POSITIVE SOLUTIONS FOR RURAL SOLID WASTE MANAGEMENT

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Abstract

Rural solid waste management is and will continue to be one of the leading environmental problems facing the twenty-first century. As the global south, under developed, and developing countries progress, proper solid waste management must be a priority to keep humans and ecosystems healthy and safe. This study provides an overview of the Republic of Macedonia's solid waste management and the discoveries of public and environmental health risks as a result of unsanitary landfills and illegal dumping. These problems are caused by low enforcement of environmental laws, minimal governmental and public support, as well as lack of funding and infrastructure. This study concludes by offering positive solutions for improvement of these solid waste management (SWM) problems, such as community organizing, proper technology, enforcing environmental laws, collecting taxes to fund proper solid waste management, and creating inter-town cleanliness competitions.

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CHAPTER 1: Introduction

1.1 Introduction and Overview

Riding down into the valley of the Kratovska River, the Osogovo Mountains surround the road. The light grey volcanic rock capping the mountain peaks stands out amongst the dark green of the oak and pine forests. Once in the bottom of the valley, the winding cobblestone streets speak to the long history of Kratovo, Macedonia. Picturesque terra cotta roofs line the streets and cover the hillside, complementing the light wall and dark beam architecture of the buildings and houses. In the center of town, the Byzantine stone bridge spans the Tabachka River and overlooks the old Turkish prison. The river flows next to the prison but the soda bottles, rags, chip bags, old tires, candy wrappers, cans, single shoes, and plastic grocery bags plastering the river bottom and its bank ruin the view. Rivers have been a means of disposing of garbage for thousands of years, carrying waste downstream to disappear. The past century has seen our waste stream change from biodegradable wastes to plastics and metals that take much longer to break down. Cheap, plentiful, and convenient disposable items combined with a lack of environmental awareness and a lack of efficient municipal waste collection led Kratovo, like many rural towns across the world, into a very serious situation of water and ground pollution.

When something is thrown away, where is away? The public does not often consider this question, but environmentalists have been asking it for years.

Unfortunately, solid waste does not disappear in the river, the trash can, or the garbage truck. This solid waste, though removed from our sight and perhaps from our general awareness, has a continued existence. Developed countries have managed their waste with infrastructure such as collection trucks, landfills, incinerators, recycling centers, and recycling reprocessing centers. These systems are effective because laws and citizens require landfills and incinerators to meet safety standards and be properly maintained in order to ensure the health and safety of the communities they serve.

Over the last thirty years, solid waste infrastructure development has not kept up with ever increasing solid waste generation in rural areas, particularly in developing countries. When the Republic of Macedonia broke off from Yugoslavia in 1991, the central government controlled both national and local level governance. However since 2004, Macedonia's national government has been decentralizing services to local municipal governments. The decentralization of services like solid waste management has been haphazard. The lack of existing infrastructure combined with decentralization problems have left Macedonia in a vulnerable spot. The author observed rural solid waste problems while conducting field research during her United States Peace Corps Service in the Republic of Macedonia. The field research conducted during the author's twenty-six month service included visiting and photographing several garbage containers, recycling containers, illegal dumpsites, and landfills, as well

as conversing with students, citizens, and municipal officials across the country. This field research will be used to explain Macedonian solid waste management throughout this thesis.

This study provides an overview of Macedonia's solid waste management and the discoveries of public and environmental health risks as a result of unsanitary landfills and illegal dumping. The causes of these problems, such as low enforcement of environmental laws, minimal governmental and public support, and lack of funding and infrastructure are discussed. This study concludes by offering positive solutions for improvement of these solid waste management (SWM) problems.

Chapter 1 provides background information on the Republic of Macedonia. Through review of relevant academic literature, Chapter 2 examines past and current findings about rural and Macedonian SWM. Unsanitary landfills and illegal dumping situations are discussed in Chapter 3, and positive solutions for more effective SWM in Macedonia is discussed in Chapter 4.

1.2 Macedonia: Background Information

The Republic of Macedonia is a landlocked country and shares a northeast border with Serbia, a northwest border with Kosovo, a western border with Albania, a southern border with Greece, and an eastern border with Bulgaria.

Macedonia has a long history, and there is archaeological evidence that suggests human presence there dates back to 3500 B.C. (Finn 2007:4). Macedonia had it's own empire under Alexander the Great from 336 to 323 B.C., and survived the Roman Empire, the Byzantine Empire, and the Ottoman Empire over the following centuries through to the early 1900s (Finn 2007:4-5).

After World War II, Macedonia became part of the new Socialist Federal Republic of Yugoslavia (Finn 2007:6). The Socialist Federal Republic of Yugoslavia was made up of the Socialist Republics of Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia, and Slovenia as well as the Socialist Autonomous Provinces of Kosovo and Vojvodina. Josip Broz Tito led Yugoslavia as the secretary-general/president of the Communist Party of Yugoslavia from 1939 to 1980, as the supreme leader of the Yugoslavian military with the rank of marshal from 1943 to 1980, as premier from 1945 to 1953, and as president from 1953 to 1980 (Federal Research Division 2010). Without a strong and popular leader after Tito's death in 1980, Yugoslavia became increasingly unstable until its eventual collapse in 1991 (Federal Research Division 2010). Since then, Macedonia has been developing as a democracy.

The Republic of Macedonia in southeast Europe is geographically small, only 9,781 square miles [25,333 km^2]. Macedonia's population is a little more than two million people with a population density of 205 people per square mile [82.2/km^2]

(Central Intelligence Agency 2010). Macedonia is facing challenges typical to a new and developing country including difficulty managing solid waste. During the time it was a part of Yugoslavia, Macedonian citizens had proper waste management services at the local level provided by the socialist government (Finn 2007:48). When it broke off from Yugoslavia in 1991, the central government controlled everything at the national and local levels. However, the small government and limited funds made it difficult for the central government to consistently provide all local governmental services (Feruglio et al. 2007:7-8). In 2004, Macedonia was organized into 84 municipalities with the capital, Skopje, being composed of ten municipalities. The national government has been working to decentralize and give local municipalities governmental control since 2004. The decentralization of services like SWM has not been smooth. Many municipalities have inconsistent garbage collection and numerous illegal dump sites (USAID 2007:84-85).

The only place the author observed that had significantly less littering and illegal dumping than other municipalities was Kruševo, Macedonia. The author and fellow Peace Corps volunteers thought that this was because of it's geographic location and it serves as a popular tourist destination. Kruševo is located on top of the Busava mountain and is the highest city in Macedonia at over 4,430 feet (1,350 meters) above sea-level. Shaped like a bowl, with the exception of the tiny town center, every street is narrowly winds on a steep slope, continually lined

with houses, walls, or fences and there are simply no convenient places to create an illegal dumpsite. Additionally, Kruševo is a historically significant to Macedonia as the location of the 1903 Ilinden Uprising and the short lived Kruševo Republic. Kruševo is home to the Makedonium monument, which is dedicated to those historical events. Every year, citizens and politicians go to Kruševo on August 2nd to celebrate Macedonian Independence Day. The Toše Proeski Memorial House is also located in Kruševo. Toše Proeski was a popular singer-songwriter who tragically died at age 26 in 2007. Kruševo was his hometown and he is still idolized by the Macedonian people, who flock to Kruševo to pay their respects to him. The author and other Peace Corps volunteers thought that the local government and citizens of Kruševo valued this tourism and worked to keep the town litter-free.

CHAPTER 2: Literature Review

2.1 Rural Solid Waste Management

While there are numerous scientific books in print that address general SWM and urban SWM, no books were found specializing in rural SWM. Additionally, there were very few academic journal articles found on the subject of rural SWM, though again many on general and urban SWM. Some principles from general and urban SWM can be applied to rural SWM, such as the optimization of waste collection routes, landfill design and components, and dealing with ground or water pollution. However, rural SWM presents a wide variety of challenges that do not exist in suburbs and cities.

As mentioned in the introduction, what people are throwing away has completely changed during very recent human history. As urban areas developed and suburbs began to sprawl, SWM was developed at the same time to accommodate for the changing waste stream. Unfortunately, this did not happen for many less developed rural areas, especially rural areas that are not connected to major transportation networks.

> According to Ted Jacobson, EPA tribal solid waste liaison and rural solid waste expert, 'The big problem is that the waste stream has changed significantly in the last 50 years.' All kinds of trade goods now are barged or air freighted into rural communities. These goods come to the

> community and everything now requires more packaging. It is the packaging that goes in the landfill. [Matsuura et al. 2008:115]

While Jacobson is speaking specifically to Alaska, what he says is true about most rural areas around the world. The packaging increases the amount of waste which adds to the convenient items that are made to be thrown away. The waste stream has changed more quickly than SWM systems have been developed. This problem is relevant to rural Macedonia and will be discussed in more detail in Chapter 3.1.

Resources like landfills are spread far apart just like rural people are spread far apart. It was found that site convenience was the most important factor in the selection of dumpsites in rural areas in developing countries and environmental impact was not usually taken into consideration (Henry et al. 2006:95). Rural areas, particularly in developing countries, may have more limited access to goods and services than their more urban counterparts. As a result rural areas must plan for their SWM to accommodate community and area specific needs. Unlike suburbs and cities, rural governments have a smaller tax base as small populations are spread out over a much larger area. More stringent regulations for the construction, operation, maintenance, and closure of landfills will increase the cost of operating landfills, especially for small communities in rural areas (Dooley and Bangsund 1994:1). To remedy this cost increase, Dooley and Bangsund found that the creation of regional landfills with transfer stations "could

reduce overall costs of solid waste transportation and disposal in North Dakota by 33 percent"(1994:4). They clarify that "[t]he situation in North Dakota is not unique" and estimate that regional waste collection facilities in sparsely populated rural counties could reduce costs, in many cases, by more than fifty percent "to other rural areas facing similar waste disposal problems" (1994:4). Regional landfills with a system of transfer stations could be a positive solution for rural Macedonia and will be discussed in Chapter 4.4.3.

Table 1: Integrated Waste Management Hierarchy (Stokoe and Teague, 1995:85)

SOURCE REDUCTION	Most Efficient Least Wasted Economic Value Least Ecological Damage
REUSE	
RECYCLE	
COMPOSTING	
INCINERATION WITH ENERGY RECOVERY	
INCINERATION FOR VOLUME REDUCTION	
OTHER FORMS OF VOLUME REDUCTION	Least Efficient Most Wasted Economic Value
LANDFILLING	Most Ecological Damage

People live farther apart from each other in rural areas which makes it harder for them to organize as a community and to develop a sense of community. This sense of community and the resulting pride in the community are essential to obtaining public support for solid waste management. Stokoe and Teague used Integrated Waste Management as a tool to "determine the most energy-efficient, least-polluting ways to deal with the various components and items of a community's solid waste stream" (1995:10). They found that source reduction and reuse are the most efficient, most economical, and create the least

ecological damage, while landfilling, which is essentially burying waste, is the least efficient, most expensive, and causes the most ecological damage (Table 1, 1995:85).

Public support and community environmental awareness are necessary for achieving the most efficient and economic SWM that creates the least ecological damage. As Henry, Yongsheng, and Jun discuss in their Kenyan SWM case study "the proper management of municipal solid waste is determined by the attitudes of people towards waste … it is the desire of the people that can keep the city clean" (2006:100). Citizens can mobilize community-based efforts for better collection and cultivation of community environmental awareness (Henry et al. 2006:99). Community members can encourage each other to create less waste, reuse, recycle, and compost even more. How to generate this much needed public support will be discussed in Chapter 4.2. Low-income communities in developing countries should look for technology appropriate for their area. Importing large garbage trucks from developed countries might turn out to be a bad idea when narrow and unpaved roads are impassable by truck and there is not a consistent source of fuel or available replacement parts for the truck (Henry et al. 2006:99). Area specific technology should be observed by all rural areas developing their SWM. SWM technology solutions for specific areas are discussed in Chapter 4.4.

The waste stream from rural areas can differ significantly from the waste stream of suburban and urban areas as well. The rural waste stream contains agricultural excesses from plants and animals, as agriculture is often a large part of rural economies. The 2004 study, titled *Integrated Waste Management for Rural Development in Egypt*, discusses how these excesses do not have to be wasted but can be bio-converted into new products such as clean energy, organic fertilizers and soil conditioners, and animal feed (Shehata et al. 2004:342). There are several integrated systems for recycling and utilization of agriculture residues such as energy, soil conditioners, water for irrigation systems, composting systems, and mushroom-animal feed systems (Shehata et al. 2004:342). All of these systems have been successful: biogas energy was produced, manure and compost enriched the soil, and crops were irrigated with treated waste water (Shehata et al. 2004:347). If these SWM tools were to be employed they could be “replacing unproductive means of waste disposal by methods that boost crop yield, save energy, improve the environment, and provide opportunities for new jobs" (Shehata et al. 2004:347). With this kind of waste management, rural areas will create less waste as well as create economic opportunities for employment and profit using a local resource that would otherwise be considered garbage. The benefits created for rural areas by the proper application of SWM are discussed in Chapter 4.5.

Proper disposal of hazardous waste in rural areas is a special concern. One approach that was successful in a 1994 study by the Iowa Waste Reduction Center at University of Northern Iowa involved the presentation of mobile workshops and demonstrations that taught clients proper hazardous waste disposal methods. When this approach was used in rural Iowa workshops, participants improved their management of hazardous wastes by increasing recycling and decreasing illegal incineration of hazardous wastes (Iowa 1994:29). Although the management of hazardous wastes is important, it is beyond the scope of this thesis which focuses on the regular waste stream of solid waste management.

It should be noted that many of these articles were published in the mid-1990s. The lack of literature available about rural SWM published in recent years is surprising.

2.2 Republic of Macedonia Solid Waste Management

Literature pertaining to SWM or rural SWM in the Republic of Macedonia is also extremely limited as there were no academic journal articles or books found in the Macedonian language or in the English language. Despite this lack of literature, the Macedonian government is aware of the current SWM practices in their country. The Ministry of Environment and Physical Planning has published information about Macedonian SWM in their National Environmental Action

Plans, or NEAPs, from 1996 and 2007. Portions of the NEAPs both discuss SWM and are bold and realistic about Macedonia's SWM problems and what must be done to address those problems.

For example, the 2007 NEAP called for the creation of a National Waste Management Plan 2009 - 2015 of the Republic of Macedonia (NWMP) which was published in 2008 by the Ministry of Environment and Physical Planning. The NWMP is also a part of Macedonia's effort to join the European Union (EU) by meeting the environmental standards accepted around Europe. The NWMP seeks to list out what should be done to "eliminate or mitigate environmental impacts caused by the existing improper waste management operations" and to prepare and implement a "cost effective and sustainable waste management system taking into account the EU key principles of waste management" (MOEPP 2007:5). The main focus of the NWMP is to establish a sustainable functioning waste management structure, to achieve goals, objectives and targets in the six year period laid out in the timeline, and to remediate some of the critical environmental problems such as point sources of pollution (MOEPP 2008:19). Point sources of pollution, single and distinctly identifiable sources of pollutant discharge, are discussed more fully in Chapter 3.1.

The Macedonian government is also aware that local governments need to assess SWM in their specific areas. As a result, the NEAPs called for each

municipality to make its own Local Environmental Action Plan, or LEAP. The Municipality of Kratovo's LEAP was honest and realistic about the current SWM problems and the numerous illegal dumpsites within its borders. Kratovo's LEAP points out that inconsistent solid waste collection, lack of programs for waste management in accordance with the law, and ineffective enforcement of penalties for littering all contribute to the creation of illegal landfills in the municipality. Further information on the Kratovo LEAP and its implementation can be found in Chapters 3.2 and 4.1.

Kratovo's citizens share similar SWM concerns as their municipal government. Peace Corps Master's International student Katrina Finn wrote her M.S. thesis, *A Study of the Households' Willingness to Contribute to an Improved Solid Waste Management Program in Kratovo, Macedonia*, for Michigan Technological University. Finn found that forty-one percent of residents surveyed said that they would participate in environmental activities to improve the condition of Kratovo's polluted rivers and twenty-six percent said they would participate in environmental campaigns (2007:66). These findings confirm that some people of Kratovo are willing to contribute to improve SWM in their town.

Finn concluded that an effective program also depends on the local government's willingness to accept and implement modern and effective ways of SWM (2007:72). Local government effectiveness will be discussed in Chapter 3

and positive solutions for improvements will be discussed in Chapter 4. Like other literature reviewed for rural SWM, Finn stated that the long-term success of proper SWM "depends on the community's consistent involvement in programs such as recycling, composting, and an understanding of environmental responsibility" (2007:72). Lack of public support from the community and how to increase it will be covered in Chapter 3 and 4.2.

Finn worked with the municipality to invite the University of Florida Chapter of Engineers Without Borders (EWB-UF) to come and assess the SWM situation in Kratovo and assist her with her research. EWB-UF prepared an "Integrated Solid Waste Management Plan (ISWMP) for submission to the Municipality of Kratovo, Macedonia in accordance with the terms and regulations of the European Union" (Engineers 2006:1). This is a comprehensive plan with several practical recommendations and solutions to Kratovo's SWM problems such as improved collection, improved landfill design, and recycling information. The EWB-UF helped design and set up Kratovo's current recycling system that has been in place since 2006. EWB-UF is still working with the Municipality of Kratovo to improve their SWM. Finn's and EWB-UF's findings are discussed further in Chapters 3.2, 4.1.2, and 4.4.3.

This literature review has provided a solid foundation of existing information about rural and Macedonian SWM. Though much of the rural SWM literature was

from the 1990s, the principals of rural SWM have not changed dramatically and this information is still very relevant to rural SWM. Macedonian SWM literature is all much more recent, as Macedonia is a young country. The Macedonian literature is full of valuable information, plans, and ideas. Several of these works from the rural and Macedonian literature reviews are used as a basis for or reinforcement of discussions pertaining to problems or positive solutions for SWM throughout this study and will be cited as such.

CHAPTER 3: Mismanagement of Solid Waste

3.1 Unsanitary Landfills

Whether it is national, state, or local, government is largely responsible for proper SWM. Kit Strange explains"[w]aste disposal became a priority, not only because of the nuisance of waste dumped in the streets but because of very real health risks. Epidemics of yellow fever, cholera, smallpox and typhus were not unknown" (2003:28). When governments do not accept SWM responsibility, the health and safety of their citizens are compromised as well as the quality of the natural environment. In the United States of America, the Environmental Protection Agency (EPA) works hard to protect people and the environment across the nation. Several states have state level environmental protection agencies that work with the national EPA to ensure their states are as safe as possible.

Developing countries are not always so lucky. The Republic of Macedonia has a Ministry of Environment and Physical Planning. This Ministry, as discussed in the literature review, has published the NEAP and required local level LEAPs and created the NWMP. The Macedonian environmental law that defines municipal responsibility for SWM is found in the Official Gazette of the Republic of Macedonia 6/2004, Article 22. These responsibilities include taking care of abandoned waste and public hygiene, creating laws to regulate the selection, collection, and transportation of municipal solid waste, cooperation with other

municipalities about SWM, and implementation of projects and investments in SWM improvement (MOEPP 2004:13).

Despite these laws and plans, most municipalities do not have the funds, will, or manpower to implement all of the regulations. Paying inspectors to monitor and evaluate SWM is out of reach. Building sanitary landfills is also extremely expensive. The United States EPA requires its municipal sanitary landfills to include the location restrictions, composite liners, leachate collection and removal systems, operating practices, groundwater monitoring, closure and postclosure care requirements, corrective action provisions, and financial assurance (EPA 2011b). Details of these can be found in Table 2.

Table 2: EPA Municipal Solid Waste Landfill Standards (EPA 2011b)

Location restrictions	Ensure that landfills are built in suitable geological areas away from faults, wetlands, flood plains, or other restricted areas.
Composite liners requirements	Include a flexible membrane (geomembrane) overlaying two feet of compacted clay soil lining the bottom and sides of the landfill, protect groundwater and the underlying soil from leachate releases.
Leachate collection and removal systems	Sit on top of the composite liner and removes leachate from the landfill for treatment and disposal.
Operating practices	Include compacting and covering waste frequently with several inches of soil help reduce odor; control litter, insects, and rodents; and protect public health.
Groundwater monitoring requirements	Requires testing groundwater wells to determine whether waste materials have escaped from the landfill.
Closure and postclosure care requirements	Include covering landfills and providing long-term care of closed landfills.
Corrective action provisions	Control and clean up landfill releases and achieves groundwater protection standards.
Financial assurance	Provides funding for environmental protection during and after landfill closure (i.e., closure and postclosure care).

The EU has similar standards. The European Commission adopted their the EU Landfill Directive in 1999. The Directive sets up a system of operating permits for landfill sites (Scharff 2006:3-4). Details of this protection can be found in Table 3.

Table 3: European Commission Landfill Directive Permit Standards (2010)

Identity	Identity of the applicant and, in some cases, of the operator
Waste Type	A description of the types and total quantity of waste to be deposited
Capacity	The capacity of the disposal site
Site Description	A description of the site
Pollution Prevention	The proposed methods for pollution prevention and abatement
Operation and Monitoring	The proposed operation, monitoring and control plan
Closure and Aftercare	The plan for closure and aftercare procedures
Financial Security	The applicant's financial security;
Impact Assessment	An impact assessment study

The EU and the United States are calling for similar regulations in pollution prevention and monitoring for potential pollution problems during landfill operation and after landfill closure. As of August 2011, there were still no sanitary landfills that meet anything like the standards of the EU or the EPA located in Macedonia, not even in the capital, Skopje. There are landfills officially recognized by the Ministry but they contain no operation plans, no monitoring plans, no assurance of funding for current or closed landfills, no liners, no leachate collection methods, no methane gas release pipes, etc.

Worse still, even with knowledge of the science and plans to improve the SWM situation, political partisanship is halting the effectiveness and implementation of these plans and laws. Two cities and their rural villages that have been experiencing such a situation are Gostivar and Tetovo.

3.1.1 Gostivar and Tetovo Landfill Pollution

The municipalities of Gostivar and Tetovo are located in the northwestern corner of the Republic of Macedonia. The most recent census in 2002 indicates that Gostivar has a population of 81,042 people and Tetovo has a slightly larger population of 86,580 people. Both of these municipalities have diverse ethnic compositions. Gositvar is 51% Albanian, 35% Macedonian, 9.8% Turkish, 2.7% Roma (formerly known as Gypsies) and 1.5% other (Republic 2002). Tetovo is 60% Albanian, 32% Macedonian, 2.2% Turkish, 2.7% Roma, and 3.1% other (Republic 2002). When it comes to municipal solid waste management, neither municipality has official recycling or composting as components of solid waste management. Both have garbage trucks that collect the solid waste from dumpsters and deposit them in nearby landfills in rural areas.

Naxhi Ismaili, head of Local Economic Development and Municipal Works of the Municipality of Gostivar, kept detailed correspondence with the author and invited her to Gostivar to see the landfill situation first hand. The Municipality of Gostivar disposed of their garbage at a site called Sushichki Bridge from 1976 to 2005 (e-mail from Ismaili to the author, May 4, 2010). During the years of operation, this landfill literally turned into mountains of garbage. One garbage mountain towers over a two story building (Figure 1) and though it is partially covered in weeds and other vegetation, rain can easily permeate the garbage here and cause pollution (Figure 2). The Sushichki Bridge site is estimated to hold 25,426,560 ft^3

[720,000 m^3] of garbage. That is enough garbage to fill up about three-fourths of the Empire State Building, about 76 of its 102 stories.

Figure 1: Sushichki Bridge Landfill, grass covered, towers over a two story building and a three story warehouse. The forest covered mountain can be seen behind the landfill. (Photo by Jessica Meyer)

This site is located next to a tributary river, Sushicka River, that leads into Macedonia's largest and most famous river, the Vardar, which has its headwaters just north of the city of Gostivar, extends across the entire middle of the country, then crosses into Greece and flows into in the Aegean Sea. The Sushichki Bridge landfill site has no liner, leachate collection system, or methane gas release pipes (e-mail from Ismaili to the author, May 4, 2010). It seems highly likely that this old landfill is polluting the ground water and the nearby Sushicka River with leachate (Zafar and Alappat 2004). Williams clarifies,

"[l]eachate represents the water which passes through the waste and water generated within the landfill site resulting in a liquid containing suspended solids, soluble components of the waste and products from the degradations of the waste by various micro-organisms" (2003:147). Leachate entering the river and polluting the groundwater presents a serious health risk to people and the natural environment.

Figure 2: Sushichki Bridge Landfill extends for almost a mile curving around the road that curves around the river. (Photo by Jessica Meyer)

Since there is no way to deal with build up of methane gas, spontaneous combustion is common, which contributes to air pollution. Much of the site is covered in grasses or other vegetation, which does help stop physical erosion of garbage down into the river. Since 2005, the Municipality of Gostivar has

deposited its waste in a new landfill called “Meckin Dol” (Bear’s Valley) that is located near the Sushichki Bridge site. Meckin Dol is not a sanitary landfill either having no liner, leachate collection system, or methane gas release pipes and is likely also polluting the natural environment (e-mail from Ismaili to the author, May 4, 2010).

Near to both the Sushichki Bridge and Meckin Dol landfills is the Rusino landfill, also located in the Municipality of Gostivar. This location was chosen as a landfill site because it was an old clay mine. The site was prepared with light bulldozing from September 2nd to October 26th 2005 and the landfill officially opened and started accepting garbage on December 14th 2007 (e-mail from Ismaili to the author, May 4, 2010).

Tetovo with other municipalities, Vrapciste, Bugoniva, and the Polog region, have been depositing their solid waste in the Rusino landfill ever since it opened. Approximately 90,000 tons [81,647 tonnes] of trash was disposed of from December 2007 to June 2009. The Rusino Landfill did not adhere to any environmental laws during the time of initial operation (e-mail from Ismaili to the author, May 4, 2010). Despite being located on an old clay mine, the clay was not compressed down to form a liner before it was opened. The clay remained loose and porous allowing leachate to flow into the Sushicka River. The amount of leachate leaking into the Sushicka River was alarming. There was so much

and it was so polluted that it could be easily seen leaking out of the landfill (Figures 3 and 4). It looks thick and black like crude oil (Figures 5, 6, and 7).

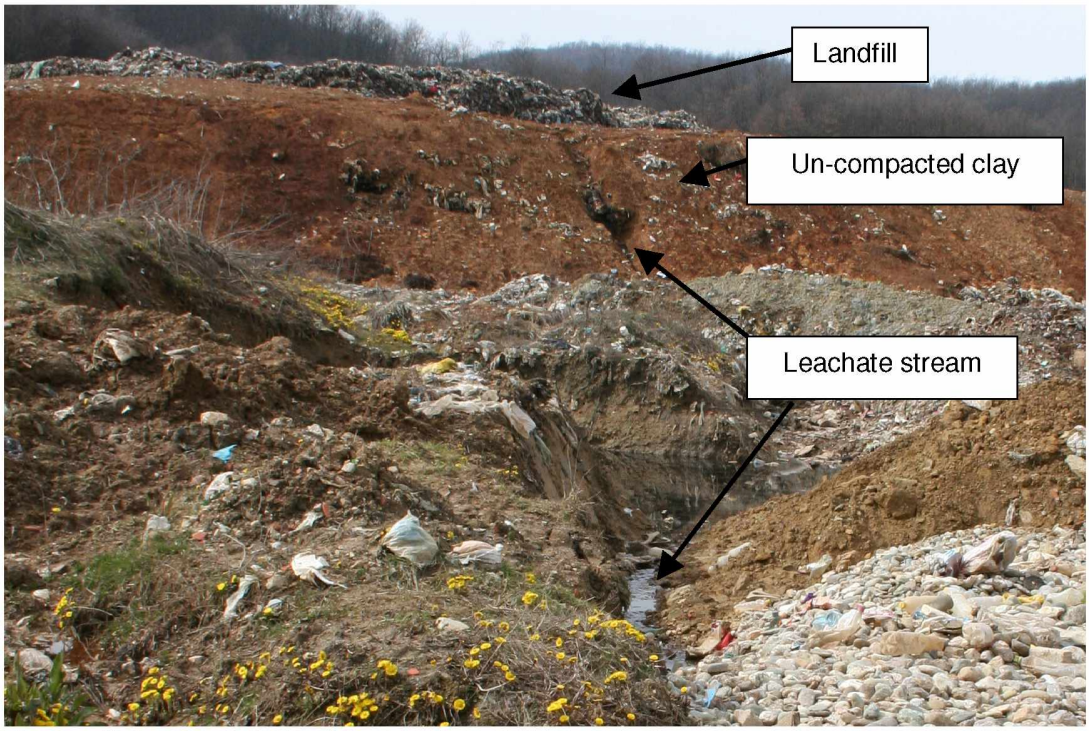


Figure 3: Layers at the Rusino Landfill where the un-compacted clay allows a leachate stream to flow out from the solid waste. (Photo by Jessica Meyer)

Figure 4: Rusino Landfill's leachate stream. (Photo by Jessica Meyer)

Figure 5: Rusino Landfill's leachate stream. (Photo by Municipality of Gostivar)

Figure 6: Rusino Landfill's leachate draining down hill. (Photo by Jessica Meyer)

Figure 7: Rusino Landfill's leachate stream. (Photo by Jessica Meyer)

Once the leachate problem was noticed, the new mayor and the Municipality of Gositvar decided to officially close the Rusino landfill site. This is because the Sushicka River flows into the Vardar River which is the source of drinking water for Gostivar and several other municipalities across the entire country of Macedonia, including Tetovo. The site was to be closed until the leachate problem could be addressed. Leachate may contain several different components "a wide range of minor components have been detected in leachate from municipal solid waste...of significance from an environmental viewpoint are the presence of a number of different compounds such as benzene, dioxins and furans of known toxicity" (Williams 2003:148). No municipalities were allowed to dump in Rusino between June 2009 and December 2009 (e-mail from Ismaili to the author, May 4, 2010).

During the time that Rusino was closed, the Municipality of Tetovo was left with nowhere to dump its large population's solid waste. Unfortunately, Tetovo decided to start dumping its garbage next to the train station (Figures 8 and 9). This site was not planned out and no environmental or safety measures were taken to ensure the health and safety of people and the natural environment. Spontaneous combustion was also common due to the unorganized way the garbage was being dumped. Additionally, this temporary landfill was purposely set on fire in order to make more room to dump solid waste. All this burning of

refuse, which included large amounts of plastic, took a toll on Tetovo's air quality (Figures 8 and 9).

Figure 8: Tetovo's temporary landfill on fire – smoke covers the city, as seen from a nearby mountain. (Photo by Kacey Molloy)

Figure 9: Tetovo's temporary landfill at the train station on fire. For scale, Kacey Molloy is 5' 7" tall (bottom photo). (Photos by Conor Molloy)

This created a great health risk to the people and the environment of Tetovo. Low-temperature burns of refuse can produce dioxins, particle pollution, polycyclic aromatic hydrocarbons, volatile organic compounds, carbon monoxide, hexachlorobenzene, and ash (Matsuura et al. 2008:113-114). The EPA warns about these dangers as well. Dioxins can alter the fundamental growth and development of cells in ways that have the potential to lead to suppression of the immune system, disruption of hormonal systems, and cancer (EPA 2009a). The EPA describes how particle pollution particles "can aggravate respiratory conditions such as asthma and bronchitis, and have been associated with cardiac arrhythmia (heartbeat irregularities) and heart attacks" and how some polycyclic aromatic hydrocarbons are cancer-causing (2009a). If certain volatile organic compounds are inhaled it "can lead to eye, nose, and throat irritation; headache; loss of coordination; nausea; and damage to liver, kidney, and central nervous system" (EPA 2009a). Even at very low exposure levels, the EPA states that carbon monoxide may lead humans to "experience a variety of neurological symptoms including headache, fatigue, nausea, and vomiting" (2009a). The EPA also notes that hexachlorobenzene "is considered a probable human carcinogen and is toxic by all routes of exposure," and that ash produced from low temperature burns can contain toxic metals such as mercury, lead, chromium, and arsenic, that when ingested can cause high blood pressure, cardiovascular problems, kidney damage, and brain damage (2009a). The people of Tetovo were being exposed to all of these dangers from the low temperature burns at

the railroad dumpsite. By August 2009, there was nowhere one could go in Tetovo or the surrounding villages that did not smell like burning garbage.

3.2 Illegal Dumping

3.2.1 Local Assessment of Illegal Dumping in Kratovo

The Municipality of Kratovo is located in the northeastern part of Macedonia and has an area of 144.96 mi^2 (375.44 km^2). This municipality borders the municipalities of Kriva Palanka, Pribishtip, Sveti Nikole, Kumanovo and Kocani. According to the latest census, the Municipality Kratovo has a total population of 10,441 inhabitants, with 6,924 residents in the City of Kratovo. The Kriva River and the Zletovska River run through the territory of Kratovo and the Kratovska River runs through the center of the City of Kratovo.

Like any developing, recently decentralized municipality today, Kratovo faces a variety of problems, but one problem that stands out is solid waste management. Kratovo's steep terrain, narrow and inaccessible streets, lack of a reliable garbage truck, insufficient public environmental awareness, and the absence of a long-term strategy for solid waste management are among the root causes of the current solid waste management situation. All of the publications from the national Ministry of Environment and Physical Planning acknowledge the great amount of littering and illegal dumping that happens but no action has been taken to prevent or even lessen this illegal dumping. The Municipality of Kratovo

clearly states in its LEAP, "[i]llegal dumpsites, because of the heavy metals, pesticides and other hazardous substances in the solid waste, present severe danger to human health" (2008:27). The LEAP goes on to say that inconsistent solid waste collection, lack of programs for waste management in accordance with the law, and ineffective enforcement of penalties for littering all contribute to continued littering and illegal dumping in the city (2008:27).

During her Peace Corps service, the author conversed with Kratovo police officers and found that many of them are hesitant to enforce the law and fine people for littering because they know that the person or family responsible for the litter can not afford to pay the fifty Euro fine. Some Kratovo citizens told the author that often the police do not enforce the littering fine because they are using their position to help family and friends not have to pay fifty Euros. The author also observed that many families of four in Kratovo live off of twenty-five Euros or less per month and was not surprised to find that several of Kratovo's police and citizens felt fifty Euros was too great a fine for what they considered a small and irrelevant misdemeanor.

In recent years, Macedonian non-governmental organizations including Sunny Hill Rajkovac Recycling and the Regional Center for Sustainable Development-Kratovo, as well as the University of Florida's Engineers Without Borders and United States Peace Corps Volunteers have made efforts to place containers for

recycling, organize education workshops, and create awareness campaigns. However, inconsistent solid waste collection, lack of programs for waste management in accordance with the Law, and ineffective enforcement of penalties for littering all contribute to the creation of illegal landfills in the Municipality of Kratovo (Municipality of Kratovo 2008).

In March 2009, the club Volunteer Ecology Kratovo (VEK) was established within the non-governmental organization the Regional Center for Sustainable Development-Kratovo by local students assisted by Peace Corps Volunteers living in Kratovo. This local environmental club is comprised of youth and adult volunteers and has engaged in litter cleaning actions in public spaces in Kratovo and has raised local awareness about various global and local environmental issues. VEK began out of concern by local student volunteers for the littering problem in Kratovo. The students were primarily concerned about the accumulation of litter and the phenomenon of illegal dumping in the town.

As VEK volunteers learned more about the negative effects of littering and illegal dumping, they began to ask questions, “How does this affect us and the people of our town?” and “If people knew what the effects were, would they continue this destructive behavior?” These very real concerns and subsequent questions led to looking for a way to raise awareness. VEK found a call for projects from the United Nations Development Program (UNDP) Hot Spots Projects - Grant for

Demonstration Projects, Public Awareness Raising and Education on Environmental Pollution. VEK members worked together to brainstorm and design a research project and fill out the application to apply for the UNDP project funding. They decided they wanted to map out the illegal dumpsites so the public would know the number and location of illegal dumpsites. They named this project “Getting the Facts, Informing the Citizens.”

First, VEK members brainstormed locations of dumping in their neighborhoods. Then they looked at the Municipality of Kratovo’s 2008 LEAP. In section 5.3.3. of the LEAP, several illegal dumpsites in the town of Kratovo are listed: in-between Carsiski and Jorkshirski Bridges, in Stara Musala, at Gligor Pazavanski Street (under Radin bridge), in the Tabacka neighborhood, in the Koshari neighborhood, in the Merak neighborhood, by the meteorological station, at the carpenter's workshop of Sileks, and along the Kratovska River. Several of these sites had already been listed during the brainstorm but there were a few new ones. VEK wanted to investigate if these illegal dumpsites still existed, determine if there were other illegal dumpsites, and inform the public of their locations and the negative effects that illegal dumps have on public health.

3.2.2 Illegal Dumping Assessment: Materials and Methods

This research project was accomplished using Global Positioning Systems (GPS) units and Geographic Information System (GIS) software. The following equipment was utilized in this project:

- One Garmin Colorado 400t Handheld GPS Unit
- Three Garmin eTrex Vista H Handheld GPS Navigator Units
- One Ricoh Caplio 500SE Model B GPS Camera
- GPS-Photo Link: GIS Pro Series Software
- Garmin MapSource Software
- Minnesota Department of Natural Resources (DNR) Garmin Software
- Environmental Systems Reaserch Institute (ESRI) ArcGIS ArcEditor Software Suite

After the equipment was received, the author trained VEK members and colleagues how to use the GPS units, the GPS camera, and the ESRI GIS software suite. The Macedonian GPS and GIS data available for download from the internet provides national scale data. No detailed local level GPS and GIS data could be found for the city or municipality of Kratovo. As a result, VEK volunteers took the GPS units and the GPS camera out into the city of Kratovo to collect and mark waypoints (latitude and longitude coordinates). Waypoints were collected by VEK members with local knowledge of prominent buildings and

landmarks, roads, rivers, sites of illegal dumps, and sites of large garbage accumulation in the rivers.

The waypoints were then synched into the computer from the Garmin GPS units. Waypoint names were organized and standardized in the Garmin MapSource Software. After waypoints were organized they were transferred back onto the Garmin GPS units and then re-downloaded into the DNR Garmin Software. Here the waypoint data was saved in text files. Then in ESRI ArcGIS Arc Map, the text files were imported as X,Y data and then exported as ESRI Shapefiles as their own geographic layers to create a map. For this project VEK used all World Geodetic System of 1984 (WGS_1984) datums and the WGS_1984_PDC_Mercator projected coordinate system.

Once the waypoints were layered on the ESRI ArcMap, the numerous waypoint tracks that represented roads and rivers were connected and made into lines instead of hundreds of points. The points around the edges of illegal dumpsites were connected to create polygons, which were colored red so they would be easily visible on the map. Once the illegal dumpsites were polygons, the area of each illegal dumpsite was calculated. Then a green hexagon symbol was added to show the points of extreme garbage accumulation in the rivers. Finally, logical symbols were chosen to represent various bridges, buildings, and landmarks

throughout Kratovo and added to the map to help show the exact locations of the illegal dumpsites.

The GPS camera photographs were downloaded into the computer. Then the GPS-Photo Link: GIS Pro Series software was used to transform the photos into ESRI Shapefiles. The Shapefiles were then imported as a layer of photographic waypoints on the map in ArcMap. Once the map included all the features necessary, a legend, scale bar, and compass rose was added and the maps were saved as jpeg and bmp files to be used in the leaflets, report, and presentation.

3.2.3 Illegal Dumping Assessment: Results

Table 4: Locations and sizes of Illegal Dumpsites (Interpolated by VEK 2010)

Illegal Dumpsites	Size
Near Argulishki Bridge and Burekov Bridge	3,552 ft^2 (330 m^2)
Merak Neighborhood	16,684 ft^2 (1550 m^2)
Koshari Neighborhood	19,687 ft^2 (1829 m^2)
Near the bridge by the Bus Station	25,769 ft^2 (2394 m^2)
Karshi Bavcha Park	33,110 ft^2 (3076 m^2)
Near Jokshirski Bridge	43,260 ft^2 (4019 m^2)
Stara Musala (Old Playground)	53,744 ft^2 (4993 m^2)

As seen in Table 4, VEK found there are seven main sites of illegal dumping around the city of Kratovo. The total combined areas of the dumpsites are

approximately 195,807 ft^2 (18,191 m^2). This is about 7% of the Empire State Building, and would take up about seven of the 102 stories.

When investigating what the LEAP calls “at Gligor Pazavanski Street (under Radin Bridge)” VEK found the two small dumpsites next to and under Argulishki Bridge and Burekov Bridge that total an area of approximately 3,552 ft^2 (330 m^2). The dumpsite at Burekov Bridge adds garbage into the Manceva River. The dumpsite at Argulishki Bridge adds garbage into the Baba Karina River. These two rivers combine to form the Sarajska River shortly after these dumpsites (Figure 10).

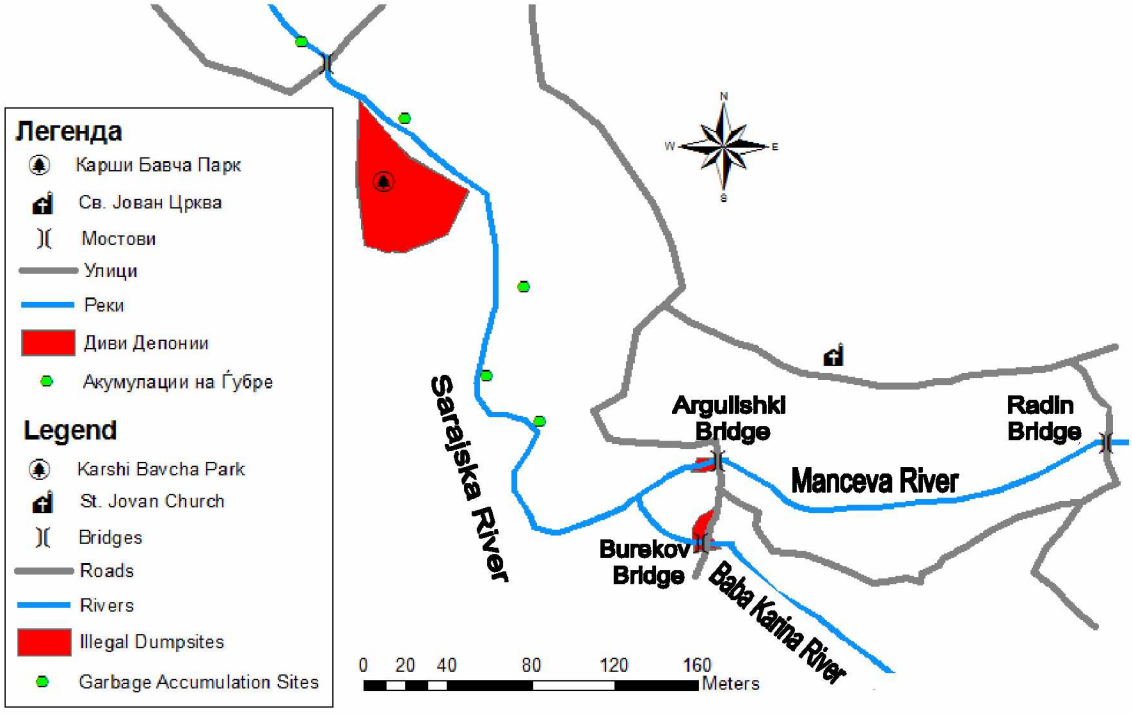


Figure 10: Argulishki Bridge, Burekov Bridge, and Karshi Bavcha Park Map of illegal dumpsites and garbage accumulation points. (Map created by VEK)

Karshi Bavcha Park is located along side the Sarajska River. The illegal dumpsite here covers most of the park and the ravine leading down to the river totaling an area of approximately 33,110 ft^2 (3076 m^2) (Figure 10). This site is not a household dumping site but a dumpsite formed by people using the park who decided that it is an acceptable place to throw garbage. This site is comprised of very little organic refuse, but a high concentration of plastic (Figure 11).

Figure 11: Illegal dumpsite at Karshi Bavcha Park. (Photo by VEK)

Also in the eastern part of town is the biggest illegal dumpsite at Stara Musala, totaling area of approximately 53,744 ft^2 (4993 m^2) (Figure 12). The enormous amounts garbage deposited in the stream valley at Stara Musala flows into the Tabachka River (Figures 13 and 14). Not only is water getting polluted here but

also numerous chickens were seen eating the garbage (Figure 15). These are chickens that will likely be part of the food chain in the form of eggs or meat.

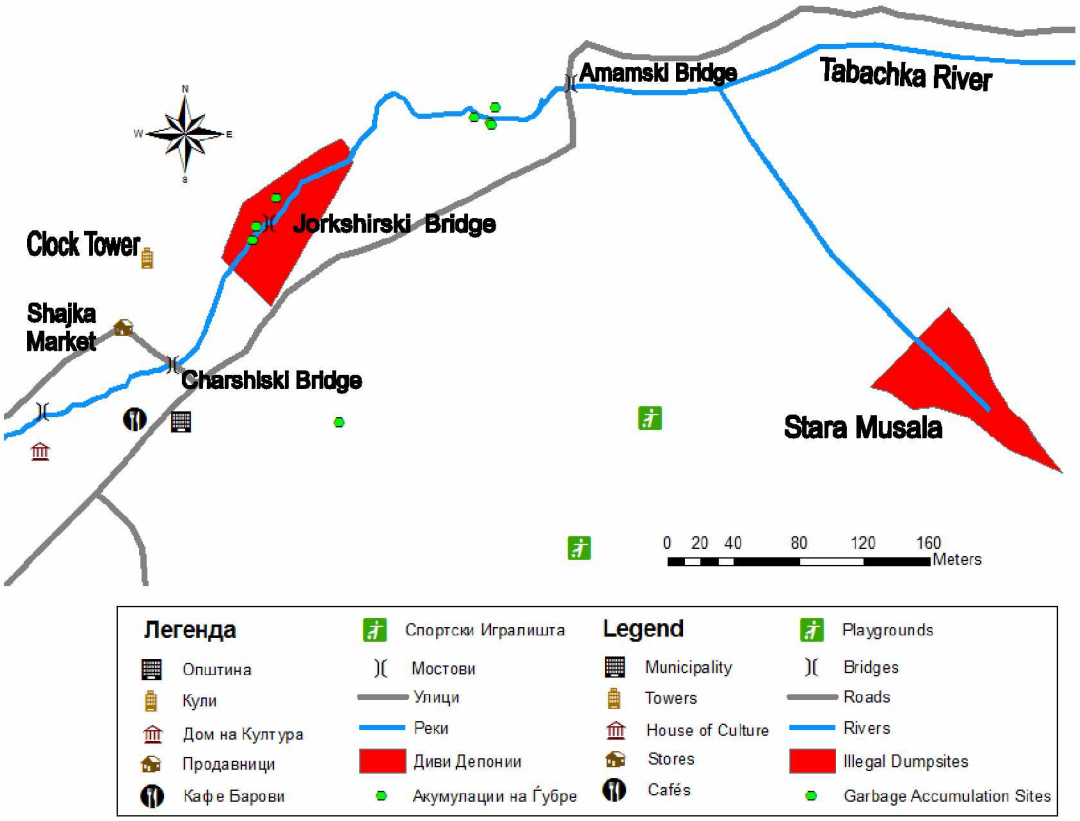


Figure 12: Stara Musala and Jorkshirski Bridge Area Map of illegal dumpsites and garbage accumulation points. (Map created by VEK)

Figure 13: Illegal dumpsite at Stara Musala. (Photo by VEK)

Figure 14: Illegal dumpsite at Stara Musala. (Photo by VEK)

Figure 15: Illegal dumpsite at Stara Musala with chicken. (Photo by VEK)

The Tabachka River flows through the town center and more garbage is added to the flow from the illegal dumpsite near the Jorkshirski Bridge. There is illegal dumping in-between Carsiski Bridge and Jokshirski Bridge but also on the other side toward Amamski Bridge as well, creating the second largest dumpsite with a total area of approximately 43,260 ft^2 (4019 m^2) (Figure 12). The Tabachka River joins the Sarajska River near the Hotel Kratis to form the Kratovska River and flows along the western part of the city.

The next significant dumpsite is near the bridge by the Bus Station with an area of approximately 25,769 ft^2 (2394 m^2) (Figures 16 and 17). The LEAP mentions “along the Kratovska River” in general but this is the most popular spot along the

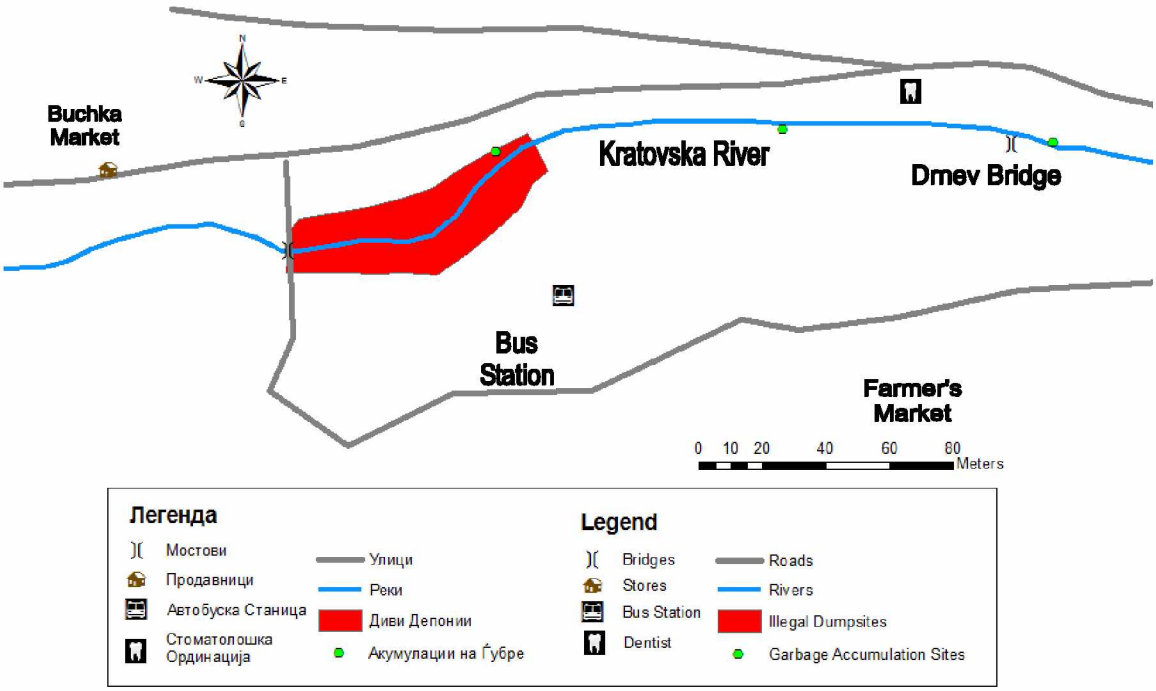


Figure 16: Near the bridge by the Bus Station Map of illegal dumpsite and garbage accumulation points. (Map created by VEK)

Kratovska River. Here the ravine is covered in garbage that will eventually end up in the Kratovska River. In the northern part of the town in a stream valley in the Koshari Neighborhood, garbage has been dumped in an area of approximately 19,687 ft^2 (1829 m^2) (Figures 18 and 19). This stream flows into the Kratovska River near the Sileks office. In the Western part of town, there is a significant illegal dumpsite at Merak Neighborhood, with an area of approximately 16,684 ft^2 (1550 m^2) (Figure 20). This is in a stream valley next to the football (soccer) stadium where the stream and garbage also empty into the Kratovska River.

Figure 17: Illegal dumpsite near the bridge by the Bus Station. (Photo by VEK)

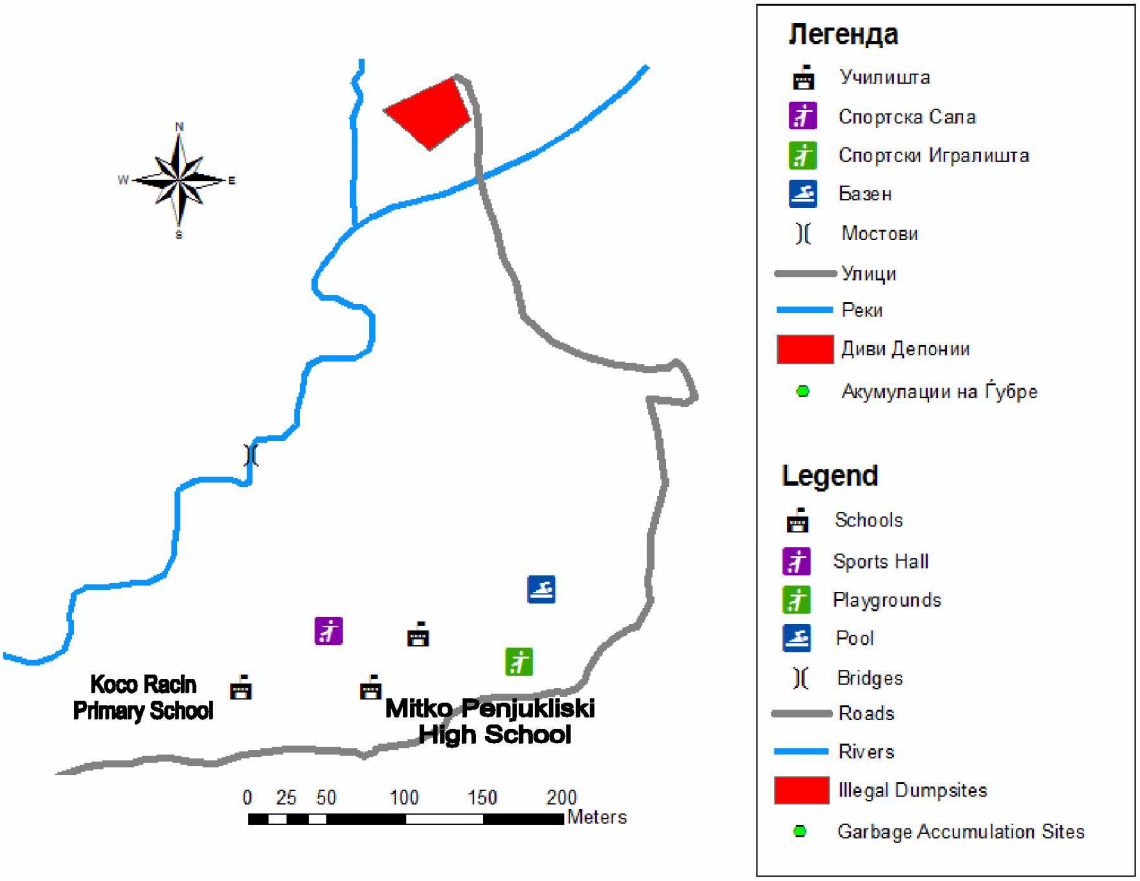


Figure 18: Koshari Neighborhood Map of illegal dumpsite (Map created by VEK)

Figure 19: Illegal dumpsite in the Koshari Neighborhood. (Photo by VEK)

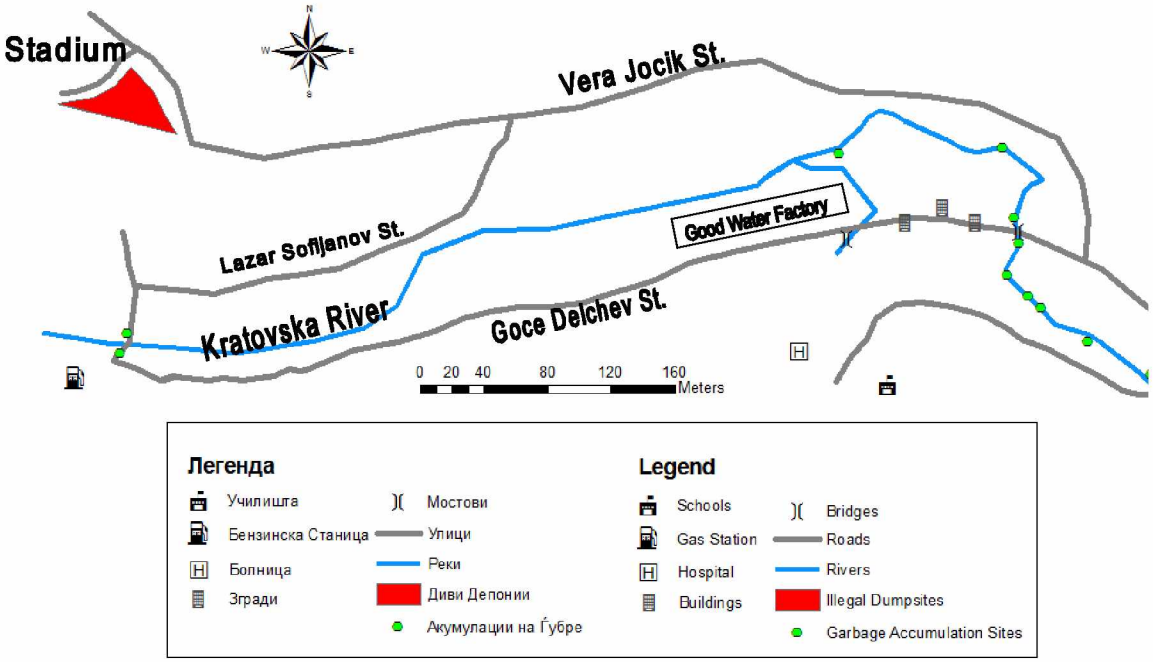


Figure 20: Merak Neighborhood Map of illegal dumpsite and garbage accumulation points in the. (Map created by VEK)

VEK observed that the illegal dumpsites at Argulishki Bridge, Burekov Bridge, and at the Merak Neighborhood were right next to places with two or three garbage dumpsters. Since the Municipality of Kratovo and the Public Utility placed garbage dumpsters here, VEK concluded that the garbage dumpsters placed here was an effort to prevent further illegal dumping. The continued presence of garbage at these sites could be due in part to for the following reasons:

a. The amount of garbage is larger than the capacity of the garbage dumpsters.
b. There was so much dumping in the past that a lot of garbage still remains and still needs to be cleaned up.

The other four large dumpsites found by VEK were not near garbage dumpsters. There are many other smaller illegal dumpsites around the city of Kratovo in addition to the seven largest sites VEK assessed. These seven dumpsites are the largest which indicates significant numbers of people are using them.

Since the seven dumpsites mentioned and most of the other smaller illegal dumpsites are located in or near the rivers, all of the streams and rivers of Kratovo have banks strewn with garbage. While collecting data it was found that in addition to the general garbage covering the riverbanks, there are 39 total points of significant garbage accumulation in the river as a result of this illegal dumping (Figure 23; see Appendix for full size map). These are spots where

large amounts of garbage have accumulated over time from floating in the rivers and streams (Figures 21 and 22).

Figure 21: Significant garbage accumulation in the Kratovska River near the police station. (Photo by Jessica Meyer)

Figure 22: Significant garbage accumulation in the Kratovska River in the river bend behind the Good Water Factory (Photo by Jessica Meyer)

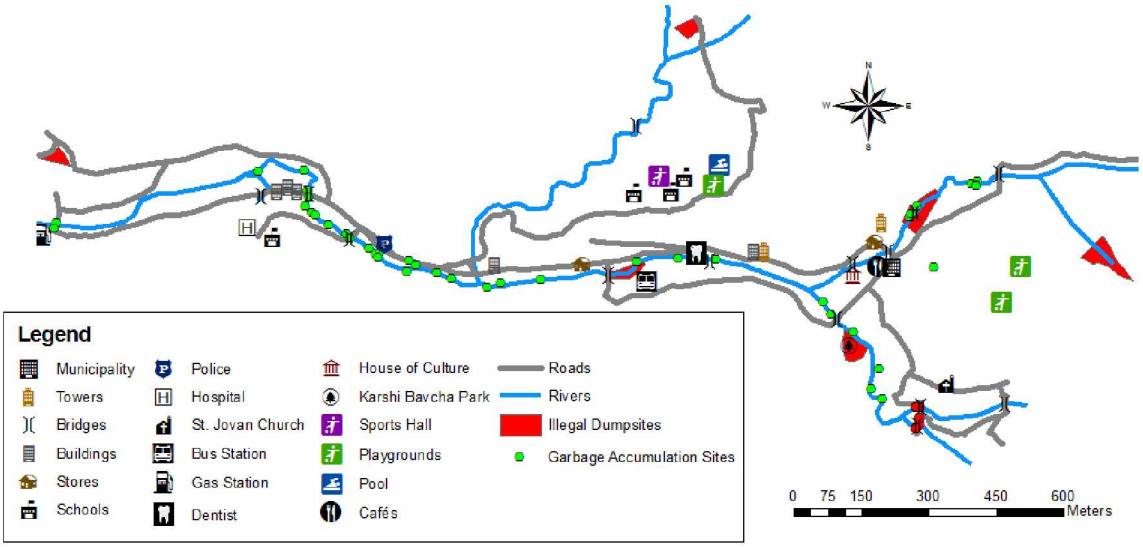


Figure 23: All illegal dumpsites and garbage accumulation points in the city of Kratovo. For full size see Appendix. (Map created by VEK)

The only significant illegal dumpsite VEK found that was not mentioned at all in the Kratovo LEAP was at Karshi Bavcha Park. The other illegal dumpsites mentioned in the LEAP are in the Tabacka Neighborhood, by the meteorological station, at the carpenter's workshop of Sileks. VEK found the Tabacka Neighborhood to be cleaner than most other parts of the town. There was much less litter here on the roads and in the river than in other parts of town. The area called “the beach” was supposed to have a lot of garbage but VEK found it to be clean (Figure 24). VEK thought that the people in this neighborhood must have stopped illegal dumping at “the beach” or one of the houses nearby has decided to clean “the beach” themselves.

The area by the meteorological station has had a building built there and if there was garbage it is no longer visible. The area by the carpenter's workshop of Sileks next to the Kratovska River along Nikola Tesla Street seems to be used less as a dumpsite than previously indicated. There is still some garbage along the slope down to the river, but not enough to indicate that many people are dumping here on a consistent basis.

Figure 24: “The Beach” in the Tabacka Neighborhood. (Photo by VEK)

3.2.4 Illegal Dumping Health Hazard Discussion

The illegal dumpsites and sites of garbage accumulation suggest that there is either little public awareness of the negative health effects illegal dumping has on humans and the natural environment or that the level of public concern is insignificant to prevent this prevalent dumping. Thirty years ago and earlier, most of the garbage thrown away in Macedonia contained natural substances. There did not used to be much plastic or dangerous chemicals contained in the garbage, so if it was thrown into illegal dumps or the river, there was much less hazardous pollution of the ground and water.

Unfortunately, most of today's garbage contains plastic or dangerous chemicals. Plastic has made life quite convenient. But plastic is made from oil and contains chemicals that are harmful for human health. Plastic will take 450 years to 1000 years to decompose completely. However, it does decompose a little bit at a time, especially if it is in water (Kumar et al. 2007). As it breaks down little by little, it releases dangerous chemicals into the water or ground.

Plastics contain endocrine disruptor chemicals, like phthalates and bisphenol A (BPA) (Koch and Calafat 2009). The endocrine system controls the hormone levels produced in the human body. Endocrine disruptor chemicals trick our bodies into thinking that they are hormones. These disrupting fake hormones can cause breast and prostate cancer, obesity, neurobehavioral problems, and reproductive abnormalities, cardiovascular disease, type 2 diabetes, and abnormalities in liver enzymes (Thompson et al. 2009, Vogel 2009).

3.3 Funding

Funding is a main factor in SWM and usually the prime culprit in solid waste mismanagement. Strange states "Inevitably, an issue at the heart of waste management decisions is who should pay" (2003:37). Who will pay for the waste collection containers from dumpsters to cans to recycle bins? Who will pay for the collection vehicle's gasoline, maintenance, and operators? Who will pay for the construction and maintenance of sanitary landfills? SWM is funded in several

different ways in the United States. United States funding and how that relates to the current funding challenges of Macedonia are discussed in the following sections.

3.3.1 United States and Alaska Funding

In the United States who pays for SWM varies by state and local government. Most U.S. citizens pay local, state and/or federal taxes that go toward SWM for municipal and hazardous waste at these levels of government. Sometimes individual citizens pay a fee to a company that collects their solid waste instead of or in addition to taxes. This is usually a private company that likely has a contract with the local government to collect for the whole city or county. The EPA states that "Traditionally, residents pay for waste collection through property taxes or a fixed fee, regardless of how much—or how little—trash they generate" (EPA 2009b).

Landfills are expensive to build in general and this expense is difficult for rural communities with small populations and small revenue streams. Examples of recent landfill construction and renovations in Alaska are relevant because Alaska and Macedonia have similar small and geographically isolated rural populations. Between 1999 and 2000, closure of an old landfill, construction of a new 80-acre landfill, a transfer station, equipment, an equipment building, a tipping floor, a recycling area, a burn box, and a debris monofill in Dillingham,

Alaska cost $6,808,300 (State of Alaska 2010). In 2001, the Matanuska-Susitna Borough began a study about the engineering design to expand the Matanuska-Susitna Borough Central Landfill (State of Alaska 2010). Following this study, between 2002 and 2009, the Matanuska-Susitna Borough constructed a lined expansion to the existing landfill, closed part of the landfill that was contaminating ground water, bought a leachate tanker, and built a light plant, a warm storage building, and an enclosed public disposal area, all of which cost $5,087,988 (State of Alaska 2010).

In Napakiak in 2008, closing an old landfill and constructing a new landfill cost $4,300,000 (State of Alaska 2010). In Sand Point, Alaska, between 1997 and 2001, $8,597,411 was spent to build a road to the new landfill, to design and construct the landfill, to design and construct a solid waste burn device, to design and construct a transfer facility and equipment storage buildings, and to close the old landfill (State of Alaska 2010). Closing an old landfill typically involves covering the landfill with a cap "to minimize infiltration of liquids and soil erosion," the creation of a leachate collection system, a groundwater monitoring system, and a methane gas monitoring system, as well as a monitoring and maintenance plan (EPA 2011a). Due to Alaska's limited road development even constructing roads to new landfill sites can be expensive. The low price roads to landfills found ranged from $10,000 to $160,000 and the high price roads to landfills

ranged from $600,000 to $8,300,000 (State of Alaska 2010). These road projects across the state were paid for by various state and federal agencies.

To open a new landfill, improve an existing landfill, build a road to a landfill, or to close an old landfill all cost millions of dollars. Often it is difficult for small rural communities to obtain such funds in the United States; in a developing country like Macedonia it is much harder. Though Macedonia is much smaller in geographic size than Alaska, it does share other similar characteristics. Like Alaska, Macedonia does not have an extensive road network and this creates an obstacle for solid waste transportation and collection. As a result, Macedonia requires solid waste infrastructure development similar to rural Alaskan communities and the cost of this development should be similar.

3.3.2 Republic of Macedonia Funding

Estimates from the World Resources Institute and USAID that several local authorities in developing countries spend over 30% of their budgets on refuse collection and disposal but are only able to collect 50–70% of the solid waste (Henry et al. 2006:94). The Republic of Macedonia, with a small area and population, has very specific laws about who should be paying for SWM. In the Official Gazette of the Republic of Macedonia 6/2004, Article 12 states the "polluter pays" principle:

> The generator and/or holder of waste shall cover all the costs generated during waste management, including the costs for waste collection, transportation, treatment, storage, disposal, prevention and monitoring, as well as the costs for the rehabilitation measures for the damage caused by the waste or the damage that might be caused by the waste. [MOEPP 2004:7]

The "polluter pays" principle is in alignment with EU SWM policies (European Commission 2010). Macedonia's currency is the denar and 45 Macedonian Denar (MKD) is worth approximately 1 US Dollar (USD) in 2010. Article 121 states that the councils of the municipalities must decide between the waste measuring units of denar/m^2, denar/m^3, or denar/kg (MOEPP 2004:57). Once units are defined, Article 123 calls for a value-added tax for waste management that should range from one percent to two percent of the price for the service of municipal waste collection and transportation (MOEPP 2004:58).

In accordance with these laws, the Municipality of Kratovo requires each household to pay 300 MKD (6.60 USD) per month for the service of solid waste collection (Finn 2007:25). Each household receives a combined utility bill for waste collection and drinking water (Finn 2007:25). Due to high unemployment in Kratovo, it was estimated that only 70% of households paid for this service in 2006 (Finn 2007:25-26). Finn describes:

> If a household does not pay for the SWM services, the household is not fined because the SWM services collect from neighborhood waste containers, not from individual trash containers. This kind of system is also common with drinking water supply. If a household does not pay for water supply, the public enterprise does not turn off the water because the only way to turn off an individual household's water supply is shutting off the entire apartment complex or street on which that apartment/household resides. [Finn 2007:26]

When the EWB-UF team asked Kratovo officials about fines for non-payment of SWM services, the officials stated that fines are in the SWM guidelines, but "these fines are rarely enforced because of the difficulties with fining a specific household as the SWM program collects from containers used by multiple households" (Finn 2007:51). From personal communications the author has had with people who work at municipalities across Macedonia, it seems that several municipalities have similar problems with collecting funds for solid waste management. Without this funding, SWM can not be effective. There will be no money to pay for gas for the collection vehicle, or to pay the collection workers, or to maintain the landfill site.

In Macedonia, as in the United States, local governments sometimes contract solid waste collection out to private companies. For the past ten years, the Municipality of Kratovo has privatized their solid waste collection to the AD Sileks

Corporation (Finn 2007:21). Sileks is involved in a variety of industries, such as mining quartzite, making polyurethane foam, and general construction. Sileks employs about five men to operate the collection truck/tractor and pick up garbage from the 160 bins placed around Kratovo and drive it to the landfill 15 kilometers (9.3 miles) from the city in the village of Zheleznica (Finn 2007:21). In the LEAP, Kratovo admits due to lack of finances the landfill is not lined or fenced which "creates significant problems with the environmental pollution" and that leachate "pollutes the underground waters and nearby land" (Municipality of Kratovo 2008:27).

The collection truck was new in 1991 and donated to Kratovo from the Norwegian Embassy in October 2004. Collection is supposedly daily except for Sundays, however the frequent observation of overflowing dumpsters for several days in a row indicates that collection is not actually daily. Though Sileks operates the truck, the truck is owned and maintained by the municipality (Finn 2007:22). This maintenance can be expensive due to the age of the truck. Maintenance combined with gas prices make SWM very expensive and is likely a reason for less than daily refuse collection in Kratovo. In 2006, waste management officials told researcher Katrina Finn that the truck breaks down often and it was difficult for the municipality to maintain its regular operation due to costs. By October of 2010, there was neither change nor improvement to this situation. An additional finding by Finn was "[b]ecause the textile factories employ

residents from Kratovo, the companies are not required to pay for the SWM services" (2007:52). These companies should be paying for their fair share for SWM services, particularly because of the low percentage of sanitation collection fees from Kratovo's citizens. Until the SWM system is stable, functional, and safe, everyone needs to pay for SWM services.

3.4 Public Support

There is still lack of public support for SWM in many developed countries as well as in developing countries. There are several reasons for this lack of support. One main reason is cost, "[c]harging is often perceived as imposing extra costs. It is seen as especially unacceptable by low income households and low recyclers, and unfair by a majority" (Strange 2003:48-49). Trust between citizens, local government, and SWM service companies needs to be built so people do not feel they are being unfairly charged. Another main reason for lack of public support for SWM is the attitude of people. Often there is a widespread perception that recycling and waste minimization is "difficult – meaning *difficult to fit into my life* rather than *difficult to use in practice*" (Strange 2003:49-50). It is necessary for there to be a mental shift to understand that properly disposing of waste, reducing how much personal waste is created, and recycling when possible are not hindrances put there to make people suffer, "[p]eople will need to be persuaded that recycling and minimization are 'normal' things to do, not just a 'good' thing" (Strange 2003:50). The perception needs to change so that

personal responsibility for SWM is something everyday, average community members do and not only the responsibility of over-achievers, environmentalists and hippies. The more citizens take personal responsibility for their solid waste, the more public support solid waste managers will have as a result.

Lack of public support and environmental awareness can be seen all over Macedonia (Figure 25). This lack of public support and awareness is stated quite clearly in the National Waste Management Plan (2009 - 2015) of the Republic of Macedonia:

> The general level of environmental awareness within Macedonia is low, and there is an insufficient understanding of environmental issues. People are not aware of waste problems and the potential risks of hazardous waste, or of the adverse effects on their health and living/natural environment. People are not aware of their own responsibilities and their role as producers of waste and actors on waste reduction. To a large extent, the increasing amount of generated waste is the result of uninformed consumers as well as of their behaviour and choices. There is limited knowledge as to what a contemporary sanitary landfill or a contemporary waste treatment facility really means; the people are used to and accept non-legal dumping of waste. There is also a lack of understanding

of the importance to pay for waste collection and disposal services. [MOEPP 2008:27]

The national government of Macedonia is aware of the big challenge they face with the low level of SWM awareness and support of their population. The national government must find ways to motivate and educate their population.

Figure 25: Illegal dump near a village called Slepche in southwest Macedonia. The sign reads "НЕ ФРЛАЈ ЃУБРЕ" which translates to "Don't Throw Garbage." (Photo by Sarah Fazekas)

Local people are content to just throw garbage near designated containers if they are full and many times the contents of the container will be burned to 'make more room' (Figure 26).

Figure 26: Burning Dumpster in Sveti Nikole, Macedonia: Garbage scattered around the dumpster and the dumpster has been set on fire to 'make more room' to hold more garbage. (Photo by Jessica Meyer)

In its LEAP, the local government of Kratovo also acknowledged that low public awareness of environmental protection joined the other reasons for the unacceptable amounts of littering and illegal dumping in their town (Municipality of Kratovo 2008:27) as mentioned in Chapter 3.1.2. VEK also concluded that the large size of the illegal dumpsites and thirty-nine points of significant garbage accumulation in the Manceva River, Baba Karina River, Sarajska River, Tabachka River, and the Kratovska River show that most of the public must be illegally dumping and littering and are unaware of or unconcerned with the environmental health risks.

CHAPTER 4: Positive Solutions

4.1 Community Action

Some groups of Macedonian citizens were upset by the instances of water and air pollution from unsanitary landfills and water pollution from illegal dumping and littering. As discussed in Chapter 3.2.1 Local Assessment of Illegal Dumping in Kratovo, Kratovo's students and non-governmental organizations proved that they cared enough to create VEK and perform community-based research to find out the facts. Part of proper SWM is community support and participation so actions taken by communities are extremely valuable and effective in creating positive change. When change is created by the community, it is more sustainable because at least part of the community supports the change. This is a key element to successful community development.

4.1.1 Tetovo Community Organizing

The people of Tetovo were outraged that there was no place they could go in the city or surrounding villages that did not smell like burning garbage. The community banded together and citizens staged a series of protests in January 2010. The first protest featured a Santa Claus giving the people of Tetovo jars of clean air (Figure 27). Protestors stood around in the town center wearing medical face masks with signs and their jars of clean air. In the second protest, citizens wearing medical face masks again marched through the city carrying banners and signs. The march finished at the train station landfill (Figure 28). The

Municipality of Tetovo's Mayor contacted the Macedonian Minister of the Environment and Physical Planning about getting the Rusino landfill reopened. Their political parties are allies.

Figure 27: Tetovo Citizens protest the burning garbage. 'Santa Claus' is passing out jars labeled "чист воздух" which translates to "clean air" to protesters all wearing medical masks. (Photos by Dragi Nedelchevski © Chkrap!*2010)

The Minister of the Environment and Physical Planning is a pediatrician with no environmental or engineering background. Many citizens believe he got the job because he is a political ally of the current ruling political party which controls 56 out of 84 municipalities, the parliament, and is the party of the president and the prime minister. The Mayor of the Municipality of Gostivar is an independent, refusing to align with either of the two major political parties. Though the mayor is popular in Gositvar, he is seen as dangerous and hostile by most of the rest of

the country, especially the leadership, who are not interested in people learning that political parties do not have to control every aspect of their lives.

Figure 28: Tetovo Citizens march to protest the burning garbage – in Macedonian “решение за губрето” and in Albanian “zgjidhje për plehrat” translates to “Solution for Garbage”and “будење” translates to “Awakening.” (Photos by Dragi Nedelchevski © Chkrap!*2010)

The pressure from the community protestors worked quickly. After only two protests over two weeks, the Minister of the Environment and Physical Planning over-rode the mayor and municipality of Gostivar’s decision to keep the Rusino landfill closed. Tetovo started dumping at the Rusino landfill again as of January 13, 2010 (e-mail from Ismaili to the author, August 28, 2010). The Ministry of Environment and Physical Planning did not require a leachate catchment and

treatment system for the reopening of the Rusino landfill. Some of the clay has been compacted to stop leachate from penetrating deep into the ground/water table and to prevent air from passing through in case of fires (e-mail from Ismaili to the author, August 28, 2010).

Since the ministry does not feel it is necessary to address the leachate, the Municipality of Gostivar has tried two systems to keep the water clean. One system collects the leachate and then sprays it back over the top of the landfill with a sprinkler system (interview with Ismaili, March 1, 2010). This system does not guarantee that all leachate will be collected and it allows for further leaking into the river. This system will also introduce an air pollution factor that did not exist previously with this polluted water being sprayed into the air, blown around by the wind and incorporated into clouds. The second system is a pool made out of clay that collects the leachate. When the pool is full it continues to leak out and pollute the river. When authorities notice the pool is full, a tractor with a cistern that is usually used to empty septic holes picks up the leachate and pours it back on top of the garbage. These “recycling” of the leachate systems will remain in place until a new concessionaire comes and decides what to do about the leachate (e-mail from Ismaili to the author, August 28, 2010).

Gostivar and Tetovo are larger cities when it comes to Macedonia’s overall population. However, all the mentioned landfill sites are located in rural villages in

the outskirts of these municipalities. This polluted water is used by rural people in their daily lives. They use the polluted water to irrigate crops that they consume themselves and that they sell to fellow citizens in the cities. Runoff enters the Sushicka River which flows through the agricultural fields of the rural villages Banjica, Fazanerija, and Turcane before it empties into the Vardar River closer to Gostivar. The polluted water is also given to livestock which also is sold to and consumed by Macedonian citizens. Alarmingly, goats, sheep, and chickens have been known to "graze" through the landfills. Their milk, eggs, and meat are consumed by the rural people as well as sold to other citizens.

This is a very difficult situation. Either both municipalities' populations are exposed to water pollution, or the Municipality of Tetovo's population is exposed to air pollution. It seems that the national and local governments of Macedonia are less concerned with environmental health and safety than they are with political partisanship. Without national leadership, legislation, and enforcement of environmental laws, it seems unlikely that the situation will improve for the citizens of Macedonia. The politicians in power are also drinking the polluted water, breathing in polluted air, and eating vegetables irrigated with polluted water and meat from animals that drank the polluted water. They are exposing themselves and their families to the dangers just as much as they are exposing their populations. Citizens must be educated about these dangers and continue

to organize and protest if they intend to see the water pollution problem addressed.

In this case, there is a positive solution to the current lose-lose SWM policy. The leachate is being collected and sprayed or poured back over the landfill. Instead of spraying or pouring the leachate back over the landfill, the collected leachate could be treated as hazardous waste water and not put back into the environment until after treatment. These measures should be supported by both municipal governments and by the national Ministry of Environment and Physical Planning. Tetovo's citizens were successful in stopping the dangerous dumping and low temperature burns at the train station with their community-organized protests. However, it seems that they were and continue to be unaware, along with most citizens of Gostivar, that the landfill is polluting their water. The public of Tetovo and Gostivar could work together and create a strong public voice to make it clear to the government that the people will not stand being exposed to air or water pollution. The public could use social media like Facebook and Twitter to raise awareness and increase numbers at public protests. This way both municipalities would have clean water and clean air.

4.1.2 Community Action to Raise Awareness

The author helped VEK students research scientific articles from peer-reviewed journals about why it is dangerous to have garbage in the water. The students

then picked out the reasons they thought were the most relevant to the people of Kratovo that might change local attitudes about illegal dumping. The VEK students created a leaflet and presentation about the locations of the illegal dumps and the dangers they presented. Both the leaflet and presentation are titled “How Illegal Dumping Affects You” to try to help people understand the information on a personal level. Adult VEK members and the author’s colleagues at the non-governmental organization the Regional Center for Sustainable Development-Kratovo helped the students with the English-Macedonian and Macedonian-English translations of technical terms used in the leaflet and presentation.

The leaflets with these findings in the Macedonian language and links to the more detailed report were distributed around Kratovo mainly by canvassing the streets and cooperating with local cafes, restaurants, and bars to leave them on the tables. Leaflets were also passed out at the presentations.

Paul Wade and the author, both Peace Corps Volunteers, helped prepare the high school student club members for the presentation to the middle school science classes. High school student VEK members then presented these findings to the eighth grade science classes. After the presentation at the school, the middle school environmental club joined VEK to clean up part of the illegal dumpsite at Karshi Bavcha Park.

The author helped prepare her colleagues to have all the knowledge they needed to do the presentations for the local government and for the public. The local government was very receptive to the findings and there was a productive dialog. The local government had plans to address some illegal dumpsites in 2011 and 2012.

VEK members all agreed that the information coming from community members to community members would be the most effective way for the information to be received. This would enable citizens to see that their fellow citizens did this research and found out this important information to share so Kratovo will be stronger and better. If the Peace Corps Volunteers did the presentations, it would be perceived that the United States or the Peace Corps were telling Macedonians what to do in their own community, which might cause people to reject the information. VEK students also agreed that peer to peer presentations would be especially beneficial for the middle school students who are tired of being told what to do by adults.

VEK members and Peace Corps Volunteers worked to create the written scientific report with the findings and recommendations in both English and Macedonian languages. Macedonian language versions of this scientific report

were given to Kratovo's municipal officials and to the national Ministry of Environment and Physical Planning.

4.1.2.1 VEK's Recommendations

In Section 9 of the LEAP: Plan for the Implementation of LEAP Kratovo, the Municipality of Kratovo has outlined plans for improved solid waste management including the removal of illegal dumps. There are three measures listed for decreasing the number of illegal dumpsites. The first measure is to create a plan for closing down the illegal dumpsites during 2009 and 2010. This plan will analyze the risks and rank the dumpsites from highest to lowest priority (2008:58). The second measure is to close down and clean up existing illegal dumpsites from 2010 to 2012. Kratovo would like to contract the closure and clean up work to an appropriate private company (2008:58). To establish continuous monitoring and inspection of illegal dumpsites into future is the third measure. This measure would prepare a plan for regular and periodical monitoring of illegal dumpsites by an authorized inspector as well as provide technical means of monitoring such as a vehicle or equipment (2008:58).

Section 10 of the LEAP: Plan for Monitoring and Evaluation outlines monitoring actions, results, evaluations that the Municipality of Kratovo can engage in with regards to solid waste. With regard to illegal dumpsites, this monitoring and evaluation expects that illegal dumpsites will be closed, plans will be made for

their remediation, the overall number of illegal dumpsites will decrease, and monitoring and inspection will be established (2008:76).

Unfortunately, as of fall 2011, the plans and actions addressed by the LEAP in these sections have not been developed or implemented within the set timelines. VEK hopes the municipality will use the report's findings to help create the closure and remediation plans for the illegal dumpsites.

VEK recommends that Kratovo's citizens use garbage dumpsters, garbage cans, and recycle bins to properly dispose of their solid waste. Like at the illegal dumpsites at Argulishki Bridge, Burekov Bridge, and at the Merak Neighborhood, citizens can throw their garbage in the containers instead of walking past the containers to throw them into the river. VEK also recommends that citizens recycle PET plastic, as plastic creates the most dangerous health situation in the environment. Kratovo has a PET plastic recycling collection system in place. The containers are placed around the town and VEK believes that citizens, once informed, will walk a little out of their way to use them.

Karshi Bavcha Park is a site of cultural and historical importance in addition to its natural value as the only park in the City of Kratovo. This park should not be neglected. VEK recommends that the illegal dumpsite at Karshi Bavcha Park should be cleaned up, new and numerous garbage containers be placed there,

that the containers be emptied regularly, and that in the future should be monitored so it remains a clean, beautiful place for local citizens and tourists.

For the other four major illegal dumpsites, VEK recommends that the Municipality of Kratovo place garbage dumpsters there for people to use. Garbage containers conveniently placed for citizens to use will help stop illegal dumping. VEK also recommends that the Municipality of Kratovo place more recycling containers around town to encourage people to recycle more. Studies have shown "'make recycling easy' was the overwhelming message from both the focus groups and the household surveys"(Strange 2003). VEK acquired four new recycle bins and placed them in areas without recycle bins during May 2010.

VEK noticed that Section 5.2 of the LEAP: Thematic Area Water does not mention pollution from garbage in the water as a problem. Considering the vast amounts of garbage in the rivers and along the banks of all the rivers in Kratovo, VEK recommends that a plan and cleanup of garbage accumulation points in the rivers be developed. VEK hopes that this water pollution from garbage is closely monitored in the future. VEK also recommends that more garbage cans are placed on the bridges to discourage garbage from being thrown into the rivers.

VEK and the Regional Center for Sustainable Development-Kratovo also offer the following recommendations to the Municipality, the Public Utility and the Ministry of Environment and Physical Planning:

a) Organize a broad action including a large number of entities to clean up existing illegal landfills
b) Set up information panels on the illegal dumping of waste
c) Strengthen monitoring and inspection services as mentioned in Section 10 of the LEAP: Plan for Monitoring and Evaluation
d) Purchase a new garbage truck that fits on most of the streets
e) Install additional bins and containers and regular collection of garbage
f) Continue and expand workshops and educational campaigns in schools and kindergartens
g) Prepare long-term strategy for solid waste management
h) Financial support to organizations that engage in selecting and recycling of waste
i) Introduce an environmental tax
j) Enact deposit refund scheme (example: plastic bottles are sold for 5 denari extra and then when the plastic bottles are returned to shops the 5 denari are refunded)

4.1.2.2 VEK Community Based Research

This research was completed by a group of Kratovo volunteers, youth and adult, who care about the people and the environment of Kratovo. All of the illegal dumpsites would not have been found without the local knowledge of the student and adult VEK club members. Some dumpsites and garbage accumulation points were well hidden and could not be found on any map. Without the research team including local people this research could not have been as beneficial to the community or presented to the community in an effective, sustainable way.

VEK hopes that the public will take this scientific information seriously. The people of Kratovo do not need to have health problems because of illegal dumping. In addition, Kratovo has great potential for economic success in the tourism sector. However, the issues addressed in this report reduce this potential for tourism development as tourists prefer to spend their vacation time in clean and healthy environments.

VEK hopes that the illegal landfills will be cleaned up by the competent institutions with in the 2010-2012 time frame listed in the LEAP. VEK recommends that the illegal dumpsites be cleaned up as soon as possible to ensure the health and safety of Kratovo's people and environment. VEK hopes that there will be greater mobility, engagement, and cooperation of all institutions to contribute towards changing the current situation. VEK hopes that local

authorities, the Public Utility Company and the local population will work towards creating a clean and healthy city that is comfortable for all residents and visitors.

4.2 Obtaining Governmental, Financial, and Public Support

The Republic of Macedonia's government has laws in place to protect the environment in terms of SWM. The mismanagement of solid waste has come from slow implementation of and lack of enforcement of these laws which is compounded by lack of funding and compounded further still by lack of public support. There is, however, a positive solution to obtaining governmental, financial, and public support called the TidyTowns competition. It is government led, is relatively inexpensive to execute, and by its existence increases public support for better SWM. The TidyTowns competition has been going on in Ireland for fifty-three years and just becomes more successful as time goes on.

4.2.1 The Tidy Towns Competition in Ireland

In 1958 the Tourism Board in Ireland, then called the Bord Fáilte, created the TidyTowns competition. In hopes of increasing tourism in Ireland, this government agency decided to "encourage communities to improve their local environment and make their area a better place to live, work and visit" (TidyTowns N.d.). In 1995, the Bord Fáilte was restructured and the Department of the Environment, Heritage and Local Government took over as the organizers of the competition which is also sponsored by SuperValu supermarkets and other

agencies (TidyTowns N.d.). This competition gets towns to compete with each other over who has the cleanest, or tidiest, town in Ireland. There are categories for population sizes as shown in Table 5.

Table 5: Categories for the TidyTowns Competition: Population size determines categories for the TidyTowns Competition [Created by Jessica Meyer from data in the TidyTowns 2010 Entry Form (Ireland 2010)].

Type	Category	Population
Village	A	Under 200
	B	201 to 1,000
Small Town	C	1,001 to 2,500
	D	2,501 to 5,000
Large Town	E	5,001 to 10,000
	F	10,001 to 15,000
Large Urban Center	G	15,001 to 25,000
	H	25,001 and over

When a town enters the competition, the town is surveyed by a panel of judges in secret between June and August. The panel is independent and made up of "adjudicators appointed by the Department of the Environment, Heritage and Local Government" (Tidy Towns N.d.). "In secret" means that they come unannounced and do not inform anyone from the town of their presence. This ensures that the town has to be clean and tidy all the time and not just for a specific day. Every town that enters is scored on ten different criteria for a total of 400 points (see Table 6).

On the entry form in the "Overall Developmental Approach" section, entrants are to list how many people are on the town's committee, show the level of voluntary commitment, show agencies and bodies that have supported their activities by

Table 6: TidyTowns criteria and descriptions [Created by Jessica Meyer from information in the TidyTowns 2010 Entry Form. British English spellings remain from the original document]. (Ireland 2010)

Criteria	Criteria Description	Mark Value
Overall Development Approach	Involvement of the local community in committee activities, partnership with local businesses and agencies, work carried out in a planned and targeted manner	50
The Built Environment	Conservation and presentation of buildings, treatment of derelict sites, design, extent and suitability of civic amenities, general use of Irish language	50
Landscaping	Appropriate selection and siting of trees, shrubs and flowers for year-round effect, maintenance of planted areas, management of open spaces	50
Wildlife and Natural Amenities	Conservation of natural amenities and wildlife areas, encouragement of wildlife, amenity walks and nature trails, appropriate access	50
Litter Control	Absence of litter and dumping, existence of regular litter patrols and other planned activities including involvement of schools, promotion of anti-litter awareness	50
Tidiness	General lack of clutter in town centre and environs, location and condition of signage, unused lamp poles, blocked footpaths, unsightly electric cables, absence of graffiti and fly-posting, traffic management, control of weed growth on kerbs	30
Waste Minimisation	Promotion of best practice, highlighting facilities, schools initiatives, segregating litter in clean-ups, working with local businesses and agencies	20
Residential Areas	Elements of the above, in particular maintenance of boundary walls, fences, gardens and communal open spaces, appropriate planting, estate signage and linkage of area to town centre	40
Roads, Streets and Back Areas	Elements of the above, in particular presentation of approach roads, streets, connecting roads, laneways and bridges	50
General Impression	Presentation of town or village as an integrated centre, including evidence of exceptional effort to overcome a particularly difficult problem	10
	TOTAL	400

providing sponsorship, resources, funding, etc (Ireland 2010). They also must explain how they communicate with their community and how they engage with local schools. In every other criteria section on the entry form they must provide a summary of projects undertaken for this year and the projects planned for the future (Ireland 2010). There are several awards to be had by the towns entering the competition. Some awards are consistent from year to year, some vary year to year. A general overview of the consistent yearly awards includes the Best New Entry Award for the highest scoring new entrant in each population category and the Endeavour Award for the biggest improvement by an entrant in each county from the previous year. The top three entrants in each county win a County Award. The top-scoring entrant in each region wins a Regional Award. Entrants could win Gold, Silver and Bronze Medals for having certain scores. There are Category Awards for the highest scoring entrants in the Village, Small Town, Large Town and Large Urban Center categories. The top prize is Ireland's Tidiest Town Award for the highest scoring entrant in the whole competition (TidyTowns N.d.).

In 1958, only 52 towns entered in the TidyTowns competition. Over time, however, TidyTowns has evolved to a point at which an average of 700 villages, towns and urban centers compete every year (TidyTowns N.d.). This competition has created a great sense of community pride and spirit for its community members. In addition to creating community pride, it has improved the natural

environment to make Ireland a healthier and safer place to live. There is much less litter on the ground or in streams or rivers. There are much fewer illegal dumpsites that could be polluting the ground and water. There is efficient collection of garbage on time with no overflowing containers or bins. Since containers and bins are emptied on time, fewer fires are started to "make room" for more garbage and create a lot of air pollution from low temperature burns. It has also made Ireland more beautiful and a very popular tourist destination.

TidyTowns can be used as an example for improving SWM anywhere and particularly in rural areas. This national government sponsored event motivated their citizens to include aesthetics and environmental health and safety as part of their community pride and identity. This would work particularly well in the Republic of Macedonia for several reasons. Finn's study, as discussed in the literature review, found that 41% of Kratovo's Macedonians would contribute to improving the condition of the polluted river in Kratovo through environmental activities (2007:66). This indicates an already existing interest by some rural Macedonians to improve their local SWM situation. Though Ireland is roughly three times the size of Macedonia in terms of area and population, the population densities are very similar with Ireland at 73.4/km^2 [190.1/mi^2] and Macedonia at 82.2/km^2 [205/mi^2] (Central Intelligence Agency 2010). Macedonia having a smaller geographic area and smaller population will only make organizing and implementing the competition easier. Additionally, Macedonian citizens tend to

have a fierce pride in their towns or cities. This existing pride could be expanded so citizens have pride in how their whole community looks, not just their property or the sidewalk directly in front of their house. If having a clean community is connected to community pride, citizens will be less likely to walk past the garbage dumpster to throw their garbage into the river because they will want their river to be cleaner than their neighboring communities river and they will want the award to prove it and will work to earn that award. This pride can be capitalized upon to make Macedonia a cleaner and therefore more tourist friendly destination as well as ensuring a clean and safe place for citizens and the natural environment. Finally, this type of competition is not very expensive to run. The only costs are getting the judging panel to each community and printing out certificates for awards or creating plaques for awards. The rest of the work is done within the community mostly for free by volunteers.

4.3 Funding Solutions

In Kit Strange's 2003 article, *Overview of Waste Management Options: Their Efficacy and Acceptability*, the conclusion ponders "who must pay for the new world of integrated waste management" and how can governments "strike a balance between charging us all as tax-payers or as consumers" (2003:50). This is a significant point. For the most part, SWM services are paid for with tax dollars not in the prices consumers pay for goods. The prices at which commodities are sold in no way include the price of disposal of that commodity.

Most of the time, the price barely reflects the manufacturing cost. Capitalist societies and most of the global market have grown and will continue to thrive with the mass consumption of cheap and easily disposable goods.

Building SWM costs into the price of items when they are purchased is one positive solution; however it seems unlikely given the current global economic system. In recent years it seems that governments are reluctant to regulate big corporations even if the rules will mean it is a safer environment for everyone today and into the future. Prime examples of this reluctance in the Untied States include: lenient mining laws, particularly mountain-top removal mining which allows local water sources to be polluted with mining rubble and tillings with little care that rural communities suffer with poisoned water and a diminished landscape; negligent emission laws and negligent enforcement of weak emission laws for coal burning plants which create acid rain and are helping to accelerate global climate change; careless regulation and careless enforcement of shallow and deep water oil drilling as seen by the six-month-long British Petroleum Deepwater Horizon oil leak of 2010; lax regulation and enforcement of fertilizer chemical pollution into streams, rivers, and oceans leading to large dead zones where algae blooms use up all available oxygen making it impossible for other aquatic life to survive. The EU has more stringent laws than the United States when it comes to regulations, but still not enough to significantly affect the price of items. However, with these developed places setting such an unsustainable

example, it seems unlikely that solid waste will be regulated more stringently by incorporating actual environmental and solid waste cost into the purchasing price of items.

As discussed earlier, usually SWM services are paid for by taxes or fees that are at a fixed price for everyone, which provides little incentive for individual households to always pay on time or to minimize the amount of waste they are producing (Strange 2003:37). There are a variety of different charging systems used through out the world. Strange points out that prices can vary due to bin size, frequency of collection, household type, property value, apartment size, or price per inhabitant (2003:37).

One way of funding SWM has been very successful around the world and comes highly recommended by the EPA. It is known as unit pricing, variable-rate pricing, or pay-as-you-throw (PAYT). In this funding system, "residents are charged for the collection of municipal solid waste—ordinary household trash—based on the amount they throw away"(EPA 2009b). The EPA explains that PAYT is simple and fair where households pay a variable rate depending on the amount of service they use (2009b). This can be a fee per bag, fee per can, or they are billed based on how much their trash weighs so the less people throw away, the less they pay which "creates a direct economic incentive to recycle more and to generate less waste" (EPA 2009b). In Belgium in the Hainaut province “unit

pricing (per bag put out for collection) resulted in 40% less waste going to landfill" (Strange 2003:37). In the United States in the State of Maine, 55% less household waste was collected for each person and costs dropped by 25% for each person, as well as increasing recycling and composting with a PAYT program (Strange 2003:38).

The EPA supports PAYT SWM because it covers three elements that are key to successful community programs: environmental sustainability, economic sustainability, and equity. The EPA explains that environmental sustainability is created because communities with PAYT have reported significant increases in recycling and reductions in waste, meaning that fewer natural resources need to be extracted and less greenhouse gases are going into the Earth's atmosphere. PAYT creates economic sustainability by helping communities pay for SWM expenses by generating revenues communities need to cover the cost of SWM including recycling and composting costs (EPA 2009b). The EPA states that PAYT creates equity for residents paying for SWM because when SWM fees are hidden in taxes or charged at a flat rate, residents who recycle and prevent waste subsidize their neighbors' wastefulness while under PAYT, residents pay only for what they throw away (2009b).

The EPA highly recommends PAYT programs to communities across the United States and the world. The EPA website is full of resources to help communities

decide and develop their own PAYT programs. The most helpful feature of the website is the SMART BET Calculator. SMART BET stands for Saving Money and Reducing Trash Benefit Evaluation Tool. It comes with detailed instructions and an easily downloadable Microsoft Excel spreadsheet to perform calculations after the community's data is entered.

PAYT could be applied successfully in rural Macedonia. Most rural areas have few or no large, residential buildings but instead have single family houses. Each house could be charged by how many bags of garbage they throw away. For Macedonian towns and cities, PAYT can become more difficult to enforce for places with apartment buildings or multi-family housing that use building wide collection dumpsters. The EPA states that "[c]ommunities have developed many different strategies to deal with this issue, ranging from high-tech measuring equipment to exempting residents in large buildings" (2009b). Each building could be charged for the amount of trash being thrown into dumpsters and neighbors could encourage each other to throw away less garbage so they have to pay less for collection. High technological options are described by the EPA:

> Dumpsters or garbage chutes could be altered to operate only when a magnetic card, trash token, or other proof of payment is used. Weight-based systems also could be used by adding a scale at the bottom of the chute that records the weight of the trash. In addition, planners could try to have building codes for new and renovated buildings amended to require

the installation of separate chutes for recycling and for garbage disposal. [2009b]

All of these high technological tracking systems are very expensive and unfortunately there is not currently an inexpensive way to track who is throwing away how much garbage in apartment buildings or multi-family housing. Since funding is a problem it is suggested that PAYT is used only in areas of Macedonia that have single-family residences. PAYT would work well in many parts of Kratovo. The steep, narrow streets of Kratovo that the garbage truck does not fit on is nearly 100% single-family residences. It would be easy for the tractor garbage collectors to pick up each residence's garbage bag or can, rather than using a pitchfork to get the contents of the dumpster into the tractor bed. They could keep a notebook to keep track of how many bags or cans they collected from each address.

4.4 Positive Solutions for SWM with Technologies

4.4.1 Incinerators

Incinerators are a positive solution to rural SWM because they are less expensive than landfills and reduce the volume of waste by turning it into ash. According to Alaska's Division of Community and Regional Affairs' Community Database Online Details about Capital Projects and Grants, incinerator projects cost $100,000 to $275,000 (2010). This is much less expensive than millions of dollars it costs to build new landfills with liners and new roads to the landfills. The

ash left over from the incinerator takes up much less space than the original solid waste "[h]igh-performance incinerators …may be especially beneficial for rural communities, where living areas for people are in fact restricted" (Matsuura et al. 2008:110).

Not only does the ash take up less space in landfills but having controlled, high temperature burns in an incinerator creates much less dangerous air pollution, "the health impacts of [municipal solid waste] incineration appear insignificant, if the emissions respect the EC regulations. In particular, the incremental concentration of pollutants from such incinerators is far below the ambient air quality guidelines of the EPA or WHO" (Rabl and Spadaro 2002:193). EC stands for the European Parliament and of the Council of the European Union and WHO stands for the World Health Organization. It is a comfort to know that emissions have been found to be at safe levels. As for the carcinogenic effects and dioxins, it has been found that

> The cancer impacts of micropollutants, in particular of dioxins, are small compared to the mortality due to ordinary particulate matter from MSW [municipal solid waste] incinerators which in turn is insignificant compared to the contribution of other sources of particulate matter or compared to other risks of everyday life. Similar conclusions about dioxins have also been reached by Eduljee and Gair. [Rabl and Spadaro 2002:193]

Incinerators are a safer way to burn garbage from the aspect of environmental health and safety. Incinerators could be a positive solution for Macedonia. It would require a large initial investment, which could be financially challenging. But if the national government or local government worked to raise the money needed for an incinerator they could reduce the volume of waste going into their landfills as well as reduce the emissions from the frequent low temperature burns happening in most Macedonian dumpsters and landfills.

4.4.2 Garbage Truck, Containers, and Composting

Katrina Finn, EWB-UF, and the author all recommend that the Municipality of Kratovo invest in a new waste collection truck. This is recommended because the trash collection vehicle needs to be able to "access the steep, narrow streets throughout the town" (Finn 2007:49). Municipal officials all "emphasized that the current waste collection truck needs to be repaired often and cannot maneuver through the steep and narrow streets efficiently" (Finn 2007:49). The SWM workers spend a lot of their time driving a slow tractor to collect waste from streets that are too narrow or steep for the truck or everywhere when the truck is broken. The SWM workers get to a garbage dumpster or container. Then they dump out the container onto the road and shovel or pitch-fork the garbage into a trailer attached to the tractor (Figure 29). A new truck would eliminate the need of this hard work and save a lot of time.

More waste dumpsters or containers are another solution to SWM in Kratovo. The environmental club VEK findings agree with municipal officials' statements "that if Kratovo had more trash containers located closer to the households then less trash would be found in the streets or dumped into the river" (Finn 2007:49).

Figure 29: Kratovo SWM workers shoveling waste into the trailer. (Photo by Jessica Meyer)

Finn and the EWB-UF studies found that much of what Kratovo citizens are throwing away is compostable. Swan et al. 's 2002 study found that it "is only relatively recently that modern society has begun to recognise the important role composting has to play in managing the ever increasing quantities of waste it produces" (2002:73). The EWB-UF are hoping to set up a community wide composting system in Kratovo at the town farmer's market (emails from the

EWB-UF team to the author, January 23, 2009 and March 2, 2009). This should be particularly effective because the market happens every Saturday morning and by Saturday afternoon and evening the containers near the market are overflowing with compostable waste. The market is located on the main road in Kratovo and would be an easy central location for collection of compostable materials and distribution of quality soil created from the compost. The municipality could charge a small fee for the soil and put the funds toward SWM operations. Composting is only one way to benefit from rural agricultural wastes. As discussed in the literature review, the Integrated Waste Management for Rural Development in Egypt study showed that agricultural wastes can be bio-converted into new products such as clean energy, organic fertilizers and soil conditioners, and animal feed (Shehata et al. 2004:342). These products could also create economic opportunities.

4.4.3 GIS Planning

Macedonian communities could use GIS in developing their SWM plans. As mentioned in literature review Chapter 2.1, Dooley and Bangsund's study recommended regional landfills with a system of transfer stations for rural areas. GIS could be used to find ideal locations for the landfills and transfer stations (1994:4). After planning out ideal locations, three to five Macedonian municipalities could pool their funds to develop transfer stations and a sanitary landfill that could serve all of their municipalities.

As mentioned in Chapter 2.3, EWB-UF prepared an Integrated Solid Waste Management Plan (ISWMP) for submission to the Municipality of Kratovo, Macedonia. One of the ISWMP's appendixes is an Optimized Solid Waste Collection System for Kratovo, Macedonia by Paul Indeglia. Indeglia explains that there were no known GPS locations of roads, houses, buildings, or garbage collection bins in 2006 so "[h]ypothetical information regarding the locations of households and commercial enterprises was utilized to provide a basis for development of a methodology for bin location optimization and can be modified once actual data is obtained" (Indeglia 2006:5). Unfortunately, Indeglia did not finish the written portion of the actual methodology but there is a series of maps that visually show methodology. These maps show the roads, estimated land use, hypothetical placements of households and hypothetical placement of waste bins. After these base maps were created, ten meter buffers were created around the land use categories of rivers and vegetation. Next, 35 meter buffers were created around each hypothetical bin location to see how many houses were being served by each bin. There were some graphs to explain how to the issues regarding overlap of buffers and how to rectify that situation (2006:29-30). Then any hypothetical houses that were not inside a buffer were observed and conclusions about bin locations were drawn. Indeglia found that for the "16 bins in the study area, one additional bin is required. For the 150 bins in the town, by proportionality, 10 additional bins are required" (2006:31). This incomplete study

can be built upon and completed by having actual data instead of hypothetical data. The non-governmental organization the Regional Center for Sustainable Development-Kratovo has three GPS units and one GPS camera. This organization and the environmental club VEK have had training in the use of the GPS units and camera. They have also been trained on how to create GIS maps using ESRI's ArcMap software.

One positive solution for Kratovo is to recreate this study using these trained citizens and their resources. First an actual map of Kratovo must be digitized. Then accurate placement of roads, households, and other land uses will be known. Then the actual locations of the bins must be collected. They could collaborate with the Municipality of Kratovo and the EWB-UF to collect the actual locations of the garbage dumpsters. Once bin locations are known they can be added as a map layer to the digitized map of Kratovo and use a buffer methodology similar to Indeglia's to analyze and optimize Kratovo's waste collection.

4.5 Benefits for Rural Areas

Rural areas will benefit from improved SWM practices. SWM improvements will enhance the quality of life for all residents. A cleaner community will also contribute directly to the economy. Tourism will increase and industrial re-location and expansion will lead to local hire.

In the Republic of Macedonia, the main solid waste that is recycled is polyethylene terephthalate (PET) or #1 plastic. All of this plastic is collected, cut up, bailed, and shipped out of the country for recycling reprocessing. This makes recycling more expensive because the price is dependant on freight costs as well as the market value of the plastic (Matsuura et al. 2008). It does not take extremely high temperatures to melt down PET plastic and create new products, so Macedonia would be able to provide the necessary energy to melt it down with out a huge energy cost. Macedonia is working hard to attract foreign investors to create more jobs and a better economy for itself. Creating a PET plastic recycling reprocessing industry in Macedonia could be a positive solution. Recycling reprocessing would be a wise industry to develop because they would save money shipping costs and create more jobs for citizens. PET plastic can be used to make plastic drink bottles, polyester fibers, and thermoformed sheet strapping. All of these items are used in Macedonia. If they were recycled and re-sold in Macedonia it would also cut down on costs of importing reprocessed PET plastic products from elsewhere. In addition, Macedonia could import PET plastic from other countries and charge them a fee to reprocess their PET plastic. It would be cheaper for most European countries to ship their plastic to nearby Macedonia for reprocessing instead of sending it on a long journey to Asia.

CHAPTER 5: Conclusion

The management of solid waste in rural Macedonia presents challenges that are typical for rural areas all over the world. When mismanagement occurs it can be due to a combination of factors that include government agencies, funding difficulties, or lack of public support and awareness. Despite these challenges or their origins there are several positive solutions to this mismanagement, like government enforcement of environmental laws, government sponsored contests or events that increase environmental awareness and public support, proper planning, and modern technologies for solid waste management are relatively inexpensive and can make a meaningful difference for rural communities. When implemented properly, these solutions will make communities cleaner, safer, and healthier as well as create economic opportunities.

The solutions discussed in this thesis are not all appropriate for every rural community. Rural populations should research which positive solid waste management solutions are helpful for areas similar to their own community. The TidyTowns competition would be appropriate for Macedonia because of its size and population density. Macedonian communities, urban and rural, are close enough together that a sense of competition between neighbors could be developed to make the contest a success. Pay-as-you-throw garbage collection fees could easily be applied to any rural area, including Macedonia, because it

charges individual people regardless of the geographic size or population density of the community.

Appropriate solid waste management solutions will vary depending on available funds and area appropriate technology. When investing funds in solid waste management technology, landfilling is not only the least efficient way to manage solid waste but it also has the most wasted economic value and causes the most ecological damage. This combined with the ash having less volume and controlled, high temperature burns create much less dangerous air pollution, which make incinerators a better choice than landfills for rural communities in Macedonia. Equipment choice also depends on community needs and the challenges facing each community, like the truck and tractor collection on narrow and steep roads are challenges in Kratovo.

In communities with access to GIS technology and users, GIS can be used for local solid waste management planning and optimization. GIS can also be used to find the perfect location for a landfill, a regional landfill and transfer sites, a recycling center, or a recycling reprocessing center. Creating an environmentally friendly recycling reprocessing industry in Macedonia by recycling its own PET plastic and by importing recyclables from other European countries has the potential to create a new huge part of Macedonia's economy. Having more

recycling centers and recycling reprocessing centers increases employment opportunities for rural areas.

In rural areas where land is used for tourism, recreation, and agriculture, proper solid waste management is of the highest importance. Community appropriate and smart solid waste management solutions can be environmentally sound and economically viable, helping Macedonia as well as be applied in other rural areas around the world. Proper solid waste management is essential to protect the health and wellness of people and the environment today and in the future.

References

Central Intelligence Agency
2010 The World Factbook. The United States Central Intelligence Agency. https://www.cia.gov/library/publications/the-world-factbook/index.html, accessed October 17, 2010.

Dooley, Frank J., and Dean A. Bangsund
1994 Managing municipal solid waste in rural communities. Choices: The Magazine of Food, Farm & Resource Issues, 4th Quarter, 9(4): 1-5.

Engineers Without Borders - University of Florida Chapter
2006 Integrated Solid Waste Management Plan for submission to the Municipality of Kratovo, Macedonia. Department of Environmental Engineering Sciences, University of Florida.

Environmental Protection Agency (EPA).
2011a Closure and Post-Closure Care Requirements for Municipal Solid Waste Landfills (MSWLFs). http://www.epa.gov/osw/nonhaz/municipal/landfill/financial/mswclose.htm, accessed October 19, 2011.
2011b Landfills: Municipal Solid Waste Landfill Standards. http://www.epa.gov/epawaste/nonhaz/municipal/landfill.htm, accessed July, 28, 2011.
2009a Backyard Burning: Human Health. United States Environmental Protection Agency. http://www.epa.gov/osw/nonhaz/municipal/backyard/health.htm, accessed September 30, 2010
2009b Pay-As-You-Throw. United States Environmental Protection Agency. http://www.epa.gov/osw/conserve/tools/payt/index.htm, accessed September 28, 2010.

European Commission 2010
2010 Environment: Waste: Landfill of Waste: Council Directive 99/31/EC of 26 April 1999 http://ec.europa.eu/environment/waste/landfill_index.htm, accessed 16 August 2011.

Federal Research Division
2010 A Country Study: Yugoslavia (Former). The Federal Research Program of the Library of Congress: Country Studies. http://memory.loc.gov/frd/cs/yutoc.html, accessed March 28, 2011.

Feruglio, Nicoletta, Jorge Martinez-Vazquez, and Andrey Timofeev
2007 Fiscal Decentralization in Macedonia: An Assessment. United Nations Development Program for Europe and the Commonwealth of Independent States. http://europeandcis.undp.org/home/show/5B200599-F203-1EE9-BA05A61F1BD91926, accessed October 8, 2010.

Finn, Katrina R
2007 A Study of the Households' Willingness to Contribute to an Improved Solid Waste Management Program in Kratovo, Macedonia. MS Thesis, Department of Civil and Environmental Engineering, Michigan Technological University.

Henry, Rotich K., Zhao Yongsheng, and Dong Jun
2006 Municipal Solid Waste Management Challenges in Developing Countries – Kenyan Case Study. Waste Management 26: 92–100.

Indeglia, Paul
2006 Optimized Solid Waste Collection System for Kratovo, Macedonia. Unpublished Appendix H of Integrated Solid Waste Management Plan for submission to the Municipality of Kratovo, Macedonia. Department of Environmental Engineering Sciences, University of Florida.

Iowa Waste Reduction Center
1994 Solutions for Rural Waste Management. University of Northern Iowa.

Ireland Department of the Environment, Heritage and Local Government
2010 TidyTowns Entry Form 2010. Ireland Department of the Environment, Heritage and Local Government and SuperValu. Whitespace Publishing Group Ltd.

Koch, Holger M., and Antonia M. Calafat.
2009 Human body burdens of chemicals used in plastic manufacture. Philosophical Transactions of the Royal Society B: Biological Sciences 364, no. 1526: 2063-2078.

Kumar, Shristi, A. A. M. Hatha, and K. S. Christi.
2007. Diversity and effectiveness of tropical mangrove soil microflora on the degradation of polythene carry bags. Revista de Biologia Tropical 55, no. 3/4: 777-786.

Matsuura, Hiroyuki, Daniel E. Lung, and Anthony Nakazawa
2008 Commentary: Solid Waste as It Impacts Community Sustainability in Alaska. Journal of Rural and Community Development 3(3): 108–122.

Ministry of Environment and Physical Planning (MOEPP)
2004 Official Gazette of the Republic of Macedonia. Law on Waste Management. Skopje, Republic of Macedonia. 6: 7-73.
2007 Second National Environmental Action Plan. Skopje, Macedonia.
2008 National Waste Management Plan (2009 - 2015) of the Republic of Macedonia (Supplement and Novelation of the National Waste Management Plan (2006-2012) for the Republic of Macedonia as based on the National Waste Management Strategy). Skopje, Macedonia.

Municipality of Kratovo.
2008 Municipality of Kratovo Local Environmental Action Plan. Ministry of Environment and Physical Planning. Republic of Macedonia. 28-82.

Rabl, Ari and Jo V. Spadaro
2002 Health Impacts of Waste Incineration. Environmental and Health Impact of Solid Waste Management Activities: Issues in Environmental Science and Technology. R.E. Hester and R.M. Harrison eds. Pp. 171-194. Royal Society of Chemistry; First Edition.

Republic of Macedonia State Statistical Office
2002 Census of Population, Households and Dwellings in the Republic of Macedonia. Electronic document, http://www.stat.gov.mk/pdf/kniga_13.pdf, accessed February 10, 2010.

Scharff, H.
2006 Sustainability and the EU Landfill Directive. The EU Sustainable Landfill Foundation. NV Afvalzorg Holding. The Netherlands. http://www.sustainablelandfillfoundation.eu/documenten/Landfill%20general/Sustainability%20and%20the%20EU%20landfill%20directive.pdf, accessed August 17, 2011.

Shehata, S.M., A. El Shimi, M.H. Elkattan, B.E. Ali, M. El-Housseini, S.A. El Sayad, M.S. Mahmoud, A.M. Zaki, Y.A. Hamdi, and A.S. El-Nawawy
2004 Integrated Waste Management for Rural Development in Egypt. Journal of Environmental Science and Health Part A - Toxic/Hazardous Substances & Environmental Engineering. Vol. A39(2): 341–349.

State of Alaska
2010 Department of Commerce, Community, and Economic Development. Division of Community and Regional Affairs. Community Database Online. Details Capital Projects and Grants. http://www.dced.state.ak.us/dca/commdb/CF_RAPIDS.cfm, accessed November 4, 2010.

Stokoe, Jim and Elizabeth Teague
1995 INTEGRATED SOLID WASTE MANAGEMENT FOR RURAL AREAS: A Planning Tool Kit for Solid Waste Managers. Land-of-Sky Regional Council.

Strange, Kit
2003 Overview of Waste Management Options: Their Efficacy and Acceptability. Environmental and Health Impact of Solid Waste Management Activities: Issues in Environmental Science and Technology. R.E. Hester and R.M. Harrison eds. Pp.1-51. Royal Society of Chemistry; First Edition.

Swan, Jillian R.M., Brian Crook, and E. Jane Gilbert
2002 Microbial Emissions from Composting Sites. Environmental and Health Impact of Solid Waste Management Activities: Issues in Environmental Science and Technology. R.E. Hester and R.M. Harrison eds. Pp.73-96. Royal Society of Chemistry; First Edition.

TidyTowns
N.d. TidyTowns. Department of the Environment, Heritage and Local Government and SuperValu. http://www.tidytowns.ie/index.php, accessed November 4, 2010.

Thompson, Richard C., Charles J. Moore, Frederick S. vom Saal and Shanna H. Swan
2009 Plastics, the environment and human health: current consensus and future trends. Philosophical Transactions of the Royal Society B: Biological Sciences 364, no. 1526: 2153-2166.

USAID
2007 USAID Decentralization Project: Republic of Macedonia 2004-2007 More Effective and Accountable Local Government. Electronic document, http://mk.dai.com/usaiddp-eng.pdf, accessed October 7, 2010.

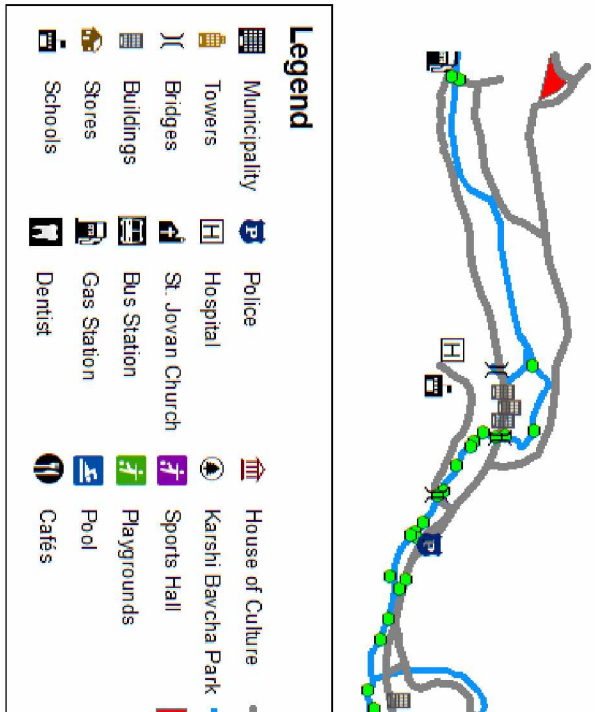
Vogel, Sarah A.
2009. The Politics of Plastics: The Making and Unmaking of Bisphenol A "Safety". American Journal of Public Health 99, no. S3: S559-S566.

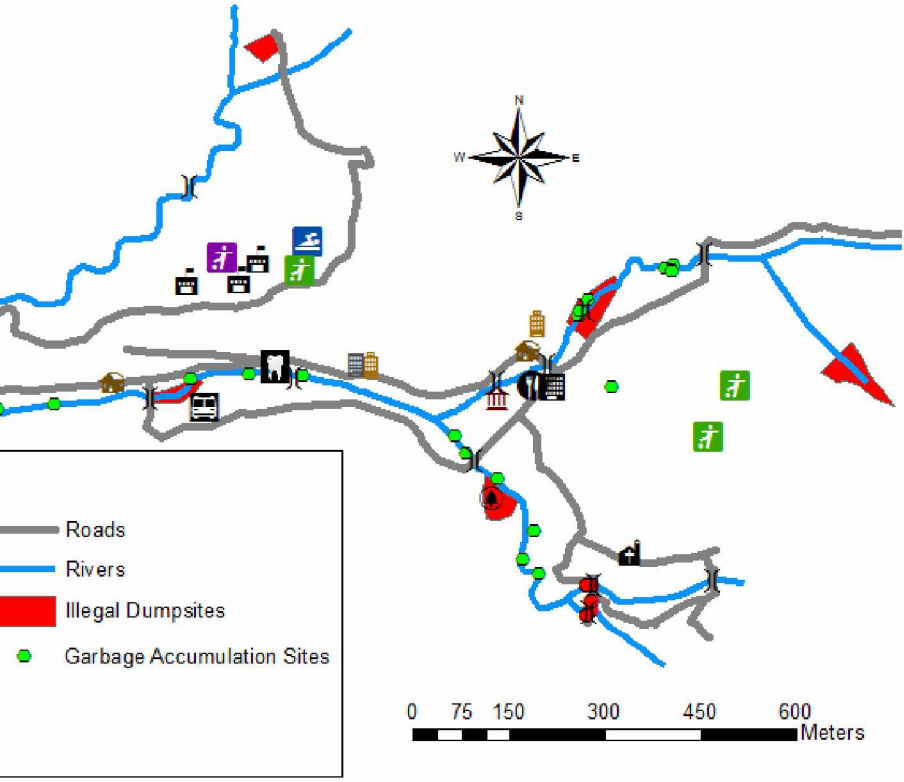
Williams, Paul T
2003 Emissions from Solid Waste Management Activities. Environmental and Health Impact of Solid Waste Management Activities: Issues in Environmental Science and Technology. R.E. Hester and R.M. Harrison eds. Pp.141-170. Royal Society of Chemistry; First Edition.

Zafar, M. and B. J. Alappat
2004 Landfill Surface Runoff and Its Effect on Water Quality on River Yamuna. Journal of Environmental Science and Health. Part A—Toxic/Hazardous Substances & Environmental Engineering. Vol. A39(2): 375–384.

Appendix:

Map of all of the illegal dumpsites and garbage accumulation points in the city of Kratovo.
(Full size version of Figure 23)




N
W
E
S
Roads
Rivers
Illegal Dumpsites
Garbage Accumulation Sites
0 75 150 300 450 600
Meters